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3-2858 TO 3-3172



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SERIALS

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Agricultural Engineering. St. Joseph, Michigan.
 Akademiya Nauk SSSR, *Izvestiya*, Geophysics Series, in English translation (American Geophysical Union). New York.
 American Mineralogist (Mineralogical Society of America). Ann Arbor, Michigan.
 Arizona Highways. Phoenix.
 Breviora (Harvard University, Museum of Comparative Zoology). Cambridge, Massachusetts.
 Cahiers de Géographie de Québec (Université Laval, Institut de Géographie). Quebec.
 California, Dept. of Water Resources, Bulletin. [Sacramento?].
 California, Division of Oil and Gas, Summary of Operations, California Oil Fields. San Francisco.
 California, University, Water Resources Center, Contribution. Berkeley.
 Canada, Geological Survey, Bulletin; Geophysics Paper; Map; Paper. Ottawa.
 Canadian Journal of Chemical Engineering (Chemical Institute of Canada). Ottawa.
 Canadian Mining Journal. Gardenvale, Quebec.
 Colorado School of Mines, Mineral Industries Bulletin; Quarterly. Golden.
 Connecticut, Geological and Natural History Survey, Quadrangle Report. Storrs.
 Earth Science. Chicago.
 Economic Geology (Society of Economic Geologists). Lancaster.
 Geochimica et Cosmochimica Acta. London-New York.
 Geokhimiya. Geochemistry; a translation of the journal of the Academy of Sciences, U.S.S.R., devoted to geochemistry (Geochemical Society). Ann Arbor, Michigan.
 Geological Magazine. London.
 Geologiya Nefti. Petroleum Geology, an English translation (Review of Russian Geology). Alexandria, Virginia.
 Geophysics (Society of Exploration Geophysicists). Tulsa, Oklahoma.
 Georgia Mineral Newsletter (Georgia, Dept. of Mines, Mining and Geology). Atlanta.
 Harvard University, Museum of Comparative Zoology, Bulletin. Cambridge, Massachusetts.
 Idaho, Bureau of Mines and Geology, Information Circular; Pamphlet. Moscow.
 Illinois, State Geological Survey, Circular. Urbana.
 International Geology Review (American Geological Institute). Washington, D.C.
 Journal of Geophysical Research. Washington, D.C.
 Journal of Glaciology (British Glaciological Society). Cambridge, England.
 Journal of Marine Research. New Haven, Connecticut.
 Journal of Paleontology. Tulsa, Oklahoma.
 Journal of Petroleum Technology (Society of Petroleum Engineers). Dallas, Texas.
 Kansas, State Geological Survey, Bulletin; Oil and Gas Investigations. Lawrence.
 Kristallografiya. Soviet Physics: Crystallography; a translation of the journal Crystallography of the Academy of Sciences, U.S.S.R. (American Institute of Physics). New York.
 Mexico, Consejo de Recursos Naturales no Renovables, Boletín. Mexico, D.F.
 Micropaleontology (American Museum of Natural History). New York.
 Mississippi, State Geological Survey, Bulletin. University.
 National Academy of Sciences-National Research Council, Publication. Washington, D.C.
 National Research Council, Highway Research Board, Bulletin. Washington, D.C.
 New York Times. New York.
 North Dakota, Geological Survey, Bulletin; Circular. Grand Forks.
 Nova Scotia, Dept. of Mines, Memoir. Halifax.
 Ohio, Division of Shore Erosion, Technical Report. Columbus.
 Ontario, Dept. of Mines, Preliminary Map; Provisional Map. Toronto.
 Ottawa, Dominion Observatory, Contribution; Publication.
 Purdue University, Engineering Extension Dept., Engineering Bulletin, Extension Series. Lafayette, Indiana.
 Science. Washington, D.C.
 Society of Vertebrate Paleontology, News Bulletin. Cambridge, Massachusetts.
 Surveying and Mapping (American Congress on Surveying and Mapping). Washington, D.C.
 U. S. Atomic Energy Commission, [Publication].
 U. S. Bureau of Land Management, Our Public Lands. Washington, D.C.
 U. S. Geological Survey, Bulletin; Geologic Quadrangle Map; Hydrologic Investigations Atlas; Mineral Investigations Map; Professional Paper; Reports, Open-File Series; Trace Elements Investigations Report; Water-Supply Paper. Washington, D.C.
 U. S. Snow, Ice and Permafrost Research Establishment, Sipre Report. Wilmette, Illinois.
 Virginia Minerals (Virginia, Dept. of Conservation and Development, Division of Geology). Charlottesville.
 Wisconsin Academy of Sciences, Arts, and Letters, Transactions. Madison.
 Zeitschrift für Geomorphologie. Berlin.

PURCHASE OF PUBLICATIONS

Those wishing to purchase items abstracted herein should address their orders to the agency, society, or organization indicated in the bibliographic citations preceding the abstracts, or to their local book dealer. The city and state for the serials cited are given above. The American Geological Institute, publisher of *GeoScience Abstracts*, regrets that it cannot fill purchase orders for abstracted publications other than its own.

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

See also: Areal and Regional Geology 3-2892 through 3-2896; Stratigraphy 3-2920; Geohydrology 3-3097, 3-3098; Fuels 3-3141, 3-3142, 3-3149, 3-3151.

3-2858. Alberta, Oil and Gas Conservation Board. MAP SHOWING THE PALEOZOIC SURFACE FOR AREA NO. FIVE, ALBERTA: scale 1 in. to 4 mi., 603 Sixth Ave., S.E., Calgary, 1961.

The second in a series of detailed maps showing the Paleozoic surface in Alberta. The first map, covering Area Four to the E., was listed as Geo-Science Abstracts 3-2. Area Five extends from Township 31 to Township 60 and from Range 18, W. of the Fourth Meridian to Range 7, W. of the Fifth Meridian. Information given on the map includes: 1) contours having a 100-ft. interval on the Paleozoic surface; 2) each major subcropping Paleozoic unit; 3) all wells.--A.C. Sangree.

3-2859. Canada, Geological Survey. BAGG LAKE, MANITOBA: Its: Geophysics Paper 1044, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°45'-60°N., long. 100°-100°30'W., 1961.

3-2860. Canada, Geological Survey. COLBECK LAKE, MANITOBA: Its: Geophysics Paper 1031, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°-59°15'N., long. 101°-101°30'W., 1961.

3-2861. Canada, Geological Survey. EGENOLF LAKE, MANITOBA: Its: Geophysics Paper 1029, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°-59°15'N., long. 100°-100°30'W., 1961.

3-2862. Canada, Geological Survey. ERICKSON LAKE, MANITOBA: Its: Geophysics Paper 1032, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°-59°15'N., long. 101°30'-102°W., 1961.

3-2863. Canada, Geological Survey. FINNER LAKE, MANITOBA: Its: Geophysics Paper 1036, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°15'-59°30'N., long. 100°-100°30'W., 1961.

3-2864. Canada, Geological Survey. HUGILL CREEK, MANITOBA: Its: Geophysics Paper 1035, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°15'-59°30'N., long. 100°30'-101°W., 1961.

3-2865. Canada, Geological Survey. KASMERE LAKE, MANITOBA: Its: Geophysics Paper 1039, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°30'-59°45'N., long. 101°-101°30'W., 1961.

3-2866. Canada, Geological Survey. PUTAHOW LAKE, MANITOBA: Its: Geophysics Paper 1043, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°45'-60°N., long. 100°30'-101°W., 1961.

3-2867. Canada, Geological Survey. SNYDER LAKE, MANITOBA: Its: Geophysics Paper 1033, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°15'-59°30'N., long. 101°30'-102°W., 1961.

3-2868. Canada, Geological Survey. SUCKER LAKE, MANITOBA: Its: Geophysics Paper 1038, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°30'-59°45'N., long. 100°30'-101°W., 1961.

3-2869. Canada, Geological Survey. THANOUT LAKE, MANITOBA: Its: Geophysics Paper 1034, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°15'-59°30'N., long. 101°-101°30'W., 1961.

3-2870. Canada, Geological Survey. TICE LAKE, MANITOBA: Its: Geophysics Paper 1042, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°45'-60°N., 101°-101°30'W., 1961.

3-2871. Canada, Geological Survey. TURNER LAKE, MANITOBA: Its: Geophysics Paper 1037, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°30'-59°45'N., long. 100°-100°30'W., 1961.

3-2872. Canada, Geological Survey. VEAL LAKE, MANITOBA: Its: Geophysics Paper 1041, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°45'-60°N., 101°30'-102°W., 1961.

3-2873. Canada, Geological Survey. WHITMORE LAKE, MANITOBA: Its: Geophysics Paper 1030, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°-59°15'N., long. 100°30'-101°W., 1961.

3-2874. Canada, Geological Survey. WOLK LAKE, MANITOBA: Its: Geophysics Paper 1040, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 59°30'-59°45'N., long. 101°30'-102°W., 1961.

3-2875. Ontario, Dept. of Mines. PART OF UNDERGROUND WORKINGS AND APPROXIMATE STRUCTURAL CONTOURS, COLEMAN TP., CONCESSIONS V & VI - LOTS 1 TO 6, DISTRICT OF TIMISKAMING, ONTARIO. Compiled by Robert Thomson: Its: Provisional Map P-97A, scale 1 in. to 400 ft., 1961.

3-2876. Ontario, Dept. of Mines. HOBBS TOWNSHIP AND WEST PART OF McCALLUM TOWNSHIP, DISTRICT OF NIPISSING: Its: Prelim. Map P.117, scale 1 in. to 1/4 mi., 1961.

3-2877. Ontario, Dept. of Mines. VOGT TOWNSHIP AND WEST PART OF TORRINGTON TOWNSHIP, DISTRICT OF NIPISSING: Its: Prelim. Map P.116, scale 1 in. to 1/4 mi., 1961.

3-2878. Petersen, Richard G. PRELIMINARY GEOLOGIC MAP OF THE PARIA PLATEAU SE QUADRANGLE, COCONINO COUNTY, ARIZONA: U.S. Geol. Survey, Mineral Inv. Map MF-196, scale 1:24,000, lat. $36^{\circ}45' - 36^{\circ}52'30''$ N., long. $111^{\circ}45' - 111^{\circ}52'30''$ W., 1961.

3-2879. Meents, Wayne F., and Alfred H. Bell. OIL AND GAS INDUSTRY IN ILLINOIS: scale approx. 1 in. to 8 mi., Urbana, Illinois, State Geological Survey, Jan. 1961.

Map shows producing and abandoned oil and gas fields; crude oil, refined products, and natural gas pipelines; pump, compressor, metering station, or terminal; refineries; propane storage; gas storage. Listed are pipeline companies, oil refineries, major natural gasoline plants, and underground storage locations.--A.C. Sangree.

3-2880. Merriam, Daniel F., and T.E. Kelly. PRELIMINARY REGIONAL STRUCTURAL CONTOUR MAP ON TOP OF "HUNTON" (SLURIAN-DEVONIAN) ROCKS IN KANSAS: Kansas, State Geol. Survey, Oil & Gas Inv., no. 23, scale approx. 1:600,000, contour interval 100 ft., 1960.

Shows also subsurface limits of "Hunton" rocks, surface and well control points, and oil and gas fields.--R.H. King.

3-2881. Merriam, Daniel F. PRELIMINARY REGIONAL STRUCTURAL CONTOUR MAP ON TOP OF MISSISSIPPIAN ROCKS IN KANSAS: Kansas, State Geol. Survey, Oil & Gas Inv., no. 22, scale approx. 1:600,000, contour interval 100 ft., 1960.

Shows also surface and subsurface limits of Mississippian rocks, surface and well control points, and oil and gas fields.--R.H. King.

3-2882. Pinckney, Darrell M., and George E. Becraft. PRELIMINARY GEOLOGIC MAP OF THE SOUTHWEST QUARTER OF THE BOULDER QUADRANGLE, MONTANA: U.S. Geol. Survey, Mineral Inv. Map MF-187, scale 1:24,000, lat. $46^{\circ} - 46^{\circ}07'30''$ N., long. $112^{\circ}07'30'' - 112^{\circ}15'W.$, 1961.

3-2883. Drake, Avery A., Jr., and others. GEOLOGY OF THE FRENCHTOWN QUADRANGLE, NEW JERSEY-PENNSYLVANIA: U.S. Geol. Survey, Geol. Quad. Map GQ-133, scale 1:24,000, lat. $40^{\circ}30' - 40^{\circ}37'30''$ N., long. $75^{\circ} - 75^{\circ}07'30''$ W., 1961.

This quadrangle covers about 56 sq. mi. along the Delaware River. About 90% of the area is underlain by clastic rocks of the Brunswick formation of Late Triassic age which are cut and thermally metamorphosed by a diabase sheet. The remainder of the area is underlain by complexly folded Precambrian gneisses and gneissoid granitic rocks. Thin bodies of Cambrian rocks are infolded and unfaulted with the Precambrian rocks.--U.S. Geol. Survey.

3-2884. Herrick, Eugene H. CONSERVATION OF FLOODWATER AT WHITE SANDS MISSILE RANGE, DONA ANA COUNTY, NEW MEXICO: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-42, scale 1:31,680, 1961.

The map and accompanying text describe the feasibility of injecting flood water into alluvial valley fill to augment the local ground-water supply. Methods

of collecting precipitation in storage ponds and of transmitting the water to underground storage are considered. Estimates are made of the possible amount of water that could be salvaged.--U.S. Geol. Survey.

3-2885. Pincus, Howard J. ENGINEERING GEOLOGY OF THE OHIO SHORE LINE OF LAKE ERIE, SHEET D - $82^{\circ}30'$ TO $82^{\circ}00'$ WEST LONGITUDE: SHORELINE FROM CEYLON JUNCTION TO AVON POINT: Ohio, Div. Shore Erosion, Tech. Rept. no. 7, 1 sheet with 6 maps, secs., diags., graphs, text, 1960, 24 refs.

Fourth of a series of 7 maps showing shoreline characteristics, offshore deposits, and description of shore types at a scale of 1:80,000 [Sheets A-C listed as GeoScience Abstracts 3-736, 3-1395, 3-1396]. The area extends along Lake Erie from just west of Vermilion, Ohio, to Avon Point. Detailed information on borings, bathymetry, phime-dians, and currents at 2 park areas in the vicinity of Lorain is shown by diagrams. Profiles and cross-sections of the bluff and nearshore bottom are also shown in detailed figures. The text accompanying the sheet summarizes notes on bedrock geology (Upper Devonian), features landward of the shore, shoreline features and deposits, nearshore features and bottom deposits, littoral drift, sources of beach building materials, hydrology, and lake levels. Seven general figures give location, wind data, wave energy data, physiography of the region, geology, lake levels, and soil types.--J.R. Hyland.

3-2886. Pincus, Howard J. ENGINEERING GEOLOGY OF THE OHIO SHORE LINE OF LAKE ERIE, SHEET E - $82^{\circ}00'$ TO $81^{\circ}30'W.$ LONGITUDE: APPROX. 1 MI. E. OF AVON LAKE VILLAGE PARK TO 1/2 MI. W. OF CUYAHOGA-LAKE COUNTY LINE: Ohio, Div. Shore Erosion, Tech. Rept. no. 7, 1 sheet with 7 maps, secs., profiles, graphs, text, 1960, 23 refs.

Fifth in a series of 7 maps showing shoreline and offshore deposits and description of shore types at a scale of 1:80,000. The area includes most of the Cuyahoga County shoreline in the vicinity of Cleveland, Ohio. The map shows details of the shoreline area and includes well-logs both onshore and offshore. A detailed map of Avon Point gives bathymetric contours and section of the bluff. Notes on Sheet E cover bedrock (Upper Devonian), features and surficial deposits landward of the shoreline, (buried valley of Cuyahoga and Rocky River), shoreline features and deposits, nearshore features and bottom deposits, littoral drift, sources of beach building materials, hydrology, and lake levels. Seven general figures show location map, wind data for Cleveland, wave energy data, physiography of the region, geology of the region, lake levels, engineering soil types.--J.R. Hyland.

3-2887. Pincus, Howard J. ENGINEERING GEOLOGY OF THE OHIO SHORE LINE OF LAKE ERIE, SHEET F - $81^{\circ}30'$ TO $81^{\circ}00'$ WEST LONGITUDE: 1/2 MILE WEST OF CUYAHOGA-LAKE COUNTY LINE TO 1/8 MILE EAST OF LAKE-ASHTABULA COUNTY LINE: Ohio, Div. Shore Erosion, Tech. Rept. no. 7, 1 sheet with 6 maps, secs., profiles, graphs, text, 1961, 25 refs.

Sixth of a series of 7 maps showing shoreline characteristics, offshore deposits, and description of shore types at a scale of 1:80,000. The area extends

along the Lake Erie shore E. of Cleveland, in the vicinity of Mentor Headlands, and covers all of Lake County, Ohio. Detailed information on the Chagrin River, Mentor Harbor, and Fairport areas is also shown in the form of sections and profiles. The text accompanying the maps gives more detail in notes on bedrock features and surficial deposits landward of the shoreline, shoreline features and deposits, near-shore features and bottom deposits, littoral drift, inferred sources of beach building materials, hydrology and lake levels, supplemented by general figures of the Lake Erie region showing location, physiography, geology, and soils. Diagrams of the lake level fluctuations, wind data, and wave energy data are included.--J. R. Hyland.

3-2888. Pincus, Howard J. **ENGINEERING GEOLOGY OF THE OHIO SHORE LINE OF LAKE ERIE, SHEET G - 81°00' TO 81°30' WEST LONGITUDE: 1/8 MILE EAST OF LAKE-ASHTABULA COUNTY LINE TO THE OHIO-PENNSYLVANIA LINE:** Ohio, Div. Shore Erosion, Tech. Rept. no. 7, 1 sheet with 6 maps, secs., profiles, graphs, text, 1961, 22 refs.

Seventh and final sheet of map series showing shoreline characteristics, offshore deposits, and geologic description of shore types at a scale of 1:80,000. The area extends from Geneva on the Lake to the Pennsylvania state line along the shore of Lake Erie and includes all of Ashtabula County. Detailed information in the form of geologic cross-sections and profiles in the area is included. An illustration of littoral drift as shown by changes of Presque Isle, Pennsylvania, is given. The text includes, in note form, information on bedrock features and surficial deposits landward of the shoreline, shoreline features and deposits, nearshore features and bottom deposits, littoral drift, inferred sources of beach building materials, hydrology, and lake levels. Seven general figures.--J. R. Hyland.

3-2889. Neuman, Robert B., and Robert L. Wilson. **GEOLOGY OF THE BLOCKHOUSE QUADRANGLE, TENNESSEE:** U.S. Geol. Survey, Geol. Quad. Map GQ-131, scale 1:24,000, contour interval 20 ft., lat. 35°37'30"-35°45'N., long. 83°52'30"-84°W., 1960, pub. 1961.

Folded and faulted Precambrian to Mississippian sedimentary rocks almost 20,000 ft. thick underlie parts of the Valley and Ridge and Blue Ridge physiographic provinces included in this quadrangle. Brecciated Lower Ordovician dolomite in one outcrop belt contains sphalerite veinlets. Alluvium, possibly as old as early Tertiary, is mapped on higher ground in the Valley and Ridge province; younger fanlike deposits blanket mountainsides in the Blue Ridge Province.--U.S. Geol. Survey.

3-2890. Neuman, Robert B. **GEOLOGY OF THE WILDWOOD QUADRANGLE, TENNESSEE:** U.S. Geol. Survey, Geol. Quad. Map GQ-130, scale 1:24,000, contour interval 20 ft., lat. 35°45'-35°52'30"N., long. 83°45'-83°52'30"W., 1960, pub. 1961.

This quadrangle, about 10 mi. S. of Knoxville, is in the Tennessee Valley except for a small segment of mountains on the SE. Exposed sedimentary rocks from Precambrian to Middle Ordovician in age, are 17,000 ft. thick. Contrasting facies of Middle Ordovician rocks are shown by the different stratigraphic sequences on opposite sides of the Dumplin Valley

fault. The Peppermint Branch fault, newly recognized, contains downfolded parts that are unusual for the region.--U.S. Geol. Survey.

3-2891. Baker, Arthur A., and Max D. Crittenden, Jr. **GEOLOGY OF THE TIMPANOGOS CAVE QUADRANGLE, UTAH:** U.S. Geol. Survey, Geol. Quad. Map GQ-132, scale 1:24,000, lat. 40°22'30"-40°30'N., long. 111°37'30"-111°45'W., 1961.

Rocks of Paleozoic, Tertiary, and Quaternary age crop in a 60-sq.-mi. area of the central Wasatch Mountains. Mount Timpanogos (11,750 ft.) and the rugged American Fork Canyon are carved from the hanging wall of a thrust that has brought together a thick (36,000-ft.) and a thin (5,000-ft.) section of Carboniferous rocks. The Wasatch fault zone, active in Pleistocene and Recent time, follows closely the western edge of the map.--U.S. Geol. Survey.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Geohydrology 3-3103; Engineering Geology 3-3163.

3-2892. Keller, A. Samuel, and others **GEOLOGY OF THE SHAVIOVK AND SAGAVANIRKOT RIVERS REGION, ALASKA. EXPLORATION OF NAVAL PETROLEUM RESERVE NO. 4 AND ADJACENT AREAS, NORTHERN ALASKA, 1944-53. PART 3, AREAL GEOLOGY:** U.S. Geol. Survey, Prof. Paper 303-D, p. 169-222, 7 figs., 6 pls. (in pocket) incl. col. geol. map, scale 1:125,000, table, 1961, 15 refs.

An uninhabited 3,200-sq. mi. glaciated area on the N. slope of the Brooks Range in arctic Alaska was investigated in 1951 and 1952 as part of the exploration of Naval Petroleum Reserve No. 4 and adjacent areas. The purposes of the investigations were to correlate the rocks of Mesozoic and late Paleozoic age in the Arctic Foothills province from the Itkillik River W. to the Canning River, and to determine the petroleum possibilities of that area.

Rocks of Mississippian to Tertiary age are present, with all systems represented except the Pennsylvanian. The rocks that crop out include the Mississippian Lisburne group, the Permian and Triassic Sadlerochit formation, the Triassic Shublik formation, the Jurassic Kingak and Tiglukpak formations, the Cretaceous Opikruak, Fortress Mountain, Torok, Tuktu, Chandler, Ninuluk, and Ignek formations, and the Tertiary Sagavanirktok formation. The Triassic and older rocks probably had a northerly source; the younger rocks, a southerly source. The sedimentary record indicates that there may have been 8 separate transgressions and regressions of the sea in the area since Permian time.

Only one intrusive mass is known in the area, a small mafic sill in the Mississippian limestone beds; its exact age is unknown.

Major deformation of the rocks in the area occurred during a Late Jurassic and Early Cretaceous orogeny and during the Tertiary. Structurally the northeastern part of the mapped area is less complex than the southwestern, but both parts are characterized to some degree by high-angle reverse faults, minor thrust faults, and eastward-trending normally asymmetric anticlines with steeper N. flanks. The mountain front is a series of en echelon folds in rocks of Paleozoic age. These folds plunge E. and W. beneath younger Mesozoic sedimentary rocks. The largest structure in the foothills part of the area is Shaviovik anticline, which is about 15 mi. long and

probably has about 1,100 ft. of closure.

The rock units which contain potential petroleum reservoir beds are the Lisburne group, the Sadlerochit and Shublik formations, the Kemik sandstone member of the Okpikruak formation, the Tuktut, Chandler, and Ninuluk formations, the lower and upper members of the Ignek formation, and the Sagavanirtoq formation.--Auth. and G. Gryc.

3-2893. Carr, Michael H. THE BEDROCK GEOLOGY OF THE NAUGATUCK QUADRANGLE, WITH MAP: Connecticut, Geol. & Nat. History Survey, Quad. Rept. no. 9, 25 p., 5 figs., geol. map (in pocket), scale 1:24,000, 1960, 12 refs.

The Naugatuck quadrangle is underlain largely by metamorphic rocks of pre-Triassic age. The oldest unit is the metasedimentary Waterbury gneiss, which occurs as a late structural dome in the northern part of the area; a different phase formerly mapped as Hartland formation is included in the Waterbury along the W. side of the area. Doming probably is later than folding. The Hartland formation of metasedimentary origin occupies the central portion of the map-area. The Straits schist member at the base is the key mapping unit, delineating folds and folded folds; the undifferentiated schistose member is partly replaced by the Prospect gneiss, presumably the result of mobilization of part of the undifferentiated member; the quartzitic member at the top was formerly mapped as part of the overlying Orange phyllite. The Orange phyllite is the youngest metasedimentary rock in the mapped area.

Small bodies of pegmatite and Ansonia granite are intrusive, probably after major metamorphism. Faulting and intrusion of dolerite dikes in Triassic time was the latest igneous-tectonic event.--Auth.

3-2894. Porter, Stephen C. THE SURFICIAL GEOLOGY OF THE WALLINGFORD QUADRANGLE, WITH MAP: Connecticut, Geol. & Nat. History Survey, Quad. Rept. no. 10, 42 p., 37 figs. (1 in pocket), geol. map (in pocket), scale 1:24,000, 1960, 18 refs.

The Wallingford 7 1/2 min. quadrangle lies in S.-central Connecticut in the middle of the Connecticut Valley lowland in which glacial and postglacial sediments irregularly mantle Triassic sedimentary and igneous bedrock.

Topography is controlled in part by the distribution of various bedrock units, especially in the upland regions, and in part by glacial deposits. In the upland regions, glacial sediments tend to be thin and their surface conforms generally to the underlying bedrock topography. In valleys thick deposits of stratified drift form topographic features that include kames, kame terraces, ice-channel fillings, kettles, and in the Quinnipiac Valley, an outwash valley train. Most of the high hills, such as Totoket Mountain, the eastern part of Mount Carmel (the "Sleeping Giant"), and several discontinuous ridges bordering Muddy River, owe their height to resistant basaltic bedrock. In this quadrangle sedimentary rocks generally underlie subdued topographic forms.

Triassic redbeds consisting of conglomerate, arkose, siltstone, and shale constitute the sedimentary bedrock of the quadrangle. Interstratified with the sedimentary rocks are three basaltic lava flows which, with related basaltic dikes and sills, constitute the igneous bedrock units of the quadrangle.

Structurally, the intercalated sedimentary rocks and basalt flows form an eastward-dipping homocline.

The attitude of the sedimentary units within the quadrangle is variable, with strikes ranging from N. 17 E. to N. 67 E., and dips ranging from 8 to 20° SE.--From auth., p. 3-4.

The preglacial history, glacial erosion, glacial deposits, postglacial deposits, soils, glacial and postglacial history, and economic geology of the area are described.

3-2895. Ross, Clyde P. GEOLOGY OF THE SOUTHERN PART OF THE LEMHI RANGE, IDAHO: U.S. Geol. Survey, Bull. 1081-F, p. 189-260, fig., 4 pls. incl. col. geol. map (in pocket), scale 1:62,500, 3 tables, 1961, 60 refs.

This report covers the southern part of the Lemhi Range and adjacent areas in Butte and Clarke counties in central Idaho. The rocks include the Swauger quartzite (Precambrian), Kinniknic quartzite (early Upper Ordovician), Saturday Mountain formation (Upper Ordovician) with remnants of Laketown dolomite (Middle Silurian) locally, several units of Devonian age that are mapped together, the Milligen formation (Mississippian), the Brazer limestone (Mississippian) and related rocks younger than the Brazer, a few dikes, patches of volcanic rocks of probable late Tertiary age, alluvial materials of Pliocene(?) and younger age and scanty glacial deposits of Quaternary age. The Paleozoic rocks vary markedly in thickness within the mapped area, and most of them are thinner than their equivalents farther N. and W. The Brazer limestone and associated beds, as mapped, are very thick and include beds of post-Mississippian age.

The Swauger quartzite was flexed before the Paleozoic rocks were laid down. The latter have been arches and, locally, complexly folded, probably in several pulses of deformation. In addition, the Brazer limestone is crumpled in unsystematic fashion. The whole assemblage has been broken by steep thrusts, apparently belonging to a single zone that has been so folded as to produce a zigzag pattern. The steep thrusts are locally overridden by more gently inclined thrusts. Relatively recently the Lemhi Range appears to have been uplifted with concomitant downflexing of the valleys on either side.

Prospecting for Pb, Zn, Cu, and other metals began in the area about 1880. Mining was inactive at the time of visit, in 1954 and 1955, but the Wilbert Pb mine has a long record of production on a rather small scale, and other properties have been active from time to time. Many of the deposits are replacements in carbonate-bearing rocks, and all are in zones of fracture, including thrust faults.--Auth.

3-2896. O'Connor, Howard G. GEOLOGY AND GROUND-WATER RESOURCES OF DOUGLAS COUNTY, KANSAS: Kansas, State Geol. Survey, Bull. 148, 200 p., 10 figs., 9 pls. incl. 2 maps (1 col., scale 1 in. to 1 mi.) and secs. (in pocket), 8 tables, 1960, 89 refs.

This report describes the geography, geology, and ground-water resources of Douglas County, Kansas, which has an area of about 474 sq. mi. The area lies within the dissected till plain and the Osage plain sections of the Central Lowlands physiographic province. Kansas River drains the northern 3/4, and tributaries of Marais des Cygnes River drain the southern 1/4. The mean annual precipitation at Lawrence is 34.57 in. Oil and gas, sand, gravel, and limestone are mineral resources currently being produced.

In Douglas County the rocks above the Precambrian basement are 2,400 to 3,000 ft. thick and are all of sedimentary origin. They include rocks of Quaternary, Pennsylvanian, Mississippian, Devonian, Ordovician, and Cambrian age. The exposed Pennsylvanian and Quaternary rocks are nearly 1,000 ft. thick; their distribution is shown on a geologic map. The thickness, attitude, and sequence of the rock units are shown in cross sections.

The dominant regional structure is the Prairie Plains monocline, which is chiefly post-Permian in age and which causes the outcropping Pennsylvanian rocks to dip northwestward about 20 ft. per mi. Faulting and small sharp flexures in southern Douglas County affect the Pedee, Douglas, and lower Shawnee rocks. The faults and folds are believed to be chiefly nontectonic in origin. Extensive submarine slides and differential compaction suggest that the structures are penecontemporaneous and probably are restricted to the post-Stanton rocks.

Wisconsinan and Recent alluvial deposits 45 to 90 ft. thick in the Kansas River valley yield large supplies of ground water and constitute the most important aquifer in the area, as more than four-fifths of the ground water pumped comes from an area of 6 sq. mi. in the Kansas River valley. Illinoian fluvial deposits and Kansan glacial and fluvial deposits locally yield small to moderate ground-water supplies. The Ireland sandstone member of the Lawrence shale and the Tonganoxie sandstone member of the Stranger formation are the most important bedrock aquifers; they provide water for domestic and stock requirements and small amounts for municipal water supplies.

Fresh ground water occurs locally to a depth of about 500 ft. Water from Quaternary deposits is generally good except for carbonate hardness and locally excessive Fe content. The Ireland and Tonganoxie sandstones yield calcium and magnesium bicarbonate water of good quality in water-table areas, and down dip or down gradient in the artesian areas they yield a sodium bicarbonate water, which is generally soft though high in dissolved solids.

Ground-water pumpage in 1955 was 2,664.4 million gallons, or 6,950 acre-ft., divided as follows: public supplies 1,610 acre-ft; industrial supplies 4,490 acre-ft; irrigation supplies 630 acre-ft; and other pumpage, 220 acre-ft. Industrial and irrigation use has greatly increased since 1950.

Field data upon which this report is based include records of 436 wells, test holes, and springs; logs of 196 wells and test holes; and chemical analyses of 113 water samples.--Auth.

3-2897. Brown, Bahngrell W. **GEOLOGIC STUDY ALONG HIGHWAY 16 FROM ALABAMA LINE TO CANTON, MISSISSIPPI**: Mississippi, State Geol. Survey, Bull. 89, 52 p., 3 figs., 2 pls., 1960, 19 refs.

A study of the geomorphology, stratigraphy, and structure along Mississippi Highway 16 from the Alabama line to Canton, Mississippi, is presented in such a fashion as to benefit both the geologist and the highway engineer. The stratigraphy and geomorphology involve geologic units belonging to the Cretaceous and Tertiary systems.

Except for a hypothetical fault E. of Philadelphia, the profile does not indicate any significant secondary structure.

The "Meridian" sand, a very important topping material, was not found to be clearly recognizable as a unit; especially questionable was the lower boundary. The overlap idea used by some workers is reviewed.

Two discrete beds, a lower "swashy" clay-breccia and an upper clay-ball conglomerate, were noted in Kemper and Neshoba counties along the strike of the Wilcox beds. These were traced from Alabama to Tennessee; however, they were not found everywhere. It is concluded that these channel deposits should not be ignored in mapping. It is believed that they may be important clues to stratigraphy, especially as they seem to occupy stratigraphic positions with moderate channel relief.

Sands suitable for topping are thickest in the Kosciusko, Neshoba, "Meridan," and lower Nanafalia ("Fearn Springs") formations. Sands are also present in the lower Cockfield and Tuscahoma.--Auth.

3-2898. Texas, University, Geological Society. **TERTIARY FIELD TRIP**: 29 p., illus., fold. map, sec., [Austin?], Dec. 1960.

The field trip led by Dr. R. L. Folk, took place Dec. 10, 1960. The guidebook contains a stratigraphic section; road map; description of outcrops; structural geology of the area; sedimentary structures; petrographic stratigraphy of the Texas Gulf Coast Tertiary; soils; vegetation; typical Claiborne fossils.--A. C. Sangree.

3-2899. Michigan Basin Geological Society. **LOWER PALEOZOIC AND PLEISTOCENE STRATIGRAPHY ACROSS CENTRAL WISCONSIN**. Compiled by C. E. Prouty: 34p., 15 figs. incl. maps, secs., Steven T. Mason Building, Lansing, Michigan, 1960, 30 refs.

The guidebook consists of road logs for the 3 days of the field trip. First day: Prairie du Chien; geomorphology and glacial geology; Jordan-Oneota; Mazomanie section. Second day: Neda iron ore; Mayville dolomite; Byron dolomite; Maquoketa shale; Cordell dolomite. Third day: Valders Ridge; Two Creeks Forest bed; Valders quarry; quarry at Quarry, Wisconsin (bioherms); Milwaukee formation.--A. C. Sangree.

2. GEOMORPHOLOGY

See also: Areal and Regional Geology 3-2894.

3-2900. Cazalis, Pierre. **GÉOMORPHOLOGIE ET PROCESSUS EXPERIMENTAL [GEOMORPHOLOGY AND EXPERIMENTAL PROCESS]**: Cahiers de Géographie de Québec, v. 5, no. 9, p. 33-50, table, Oct. 1960-March 1961, refs.; text in French, summ. in English.

For many years systematically concerned with the

complementary disciplines of fundamental research and practical application, the science of geomorphology is now beginning to be removed from its classical purpose - the contribution to the understanding of geographical milieu - and to be extended to other more technical and nongeographical fields.

Whether or not the new geomorphology remains in the academic ranks of geography, it is nonetheless necessary to redefine its methods, concepts, spirit,

and in certain ways to abandon all empiricism, verbalism, and apriority.

Accordingly the science of geomorphology must be elaborated in terms of the general principles of experimental method and analytical process, the main lines of which, in epistemological perspective, are outlined here: trial and experimentation, inductive reasoning, experimental concepts.--Auth.

3-2901. Schultz, Gwen M. **GEOGRAPHY IN THE LANDSCAPE: Surveying & Mapping**, v. 20, no. 4, p. 469-474, 4 figs., Dec. 1960, 11 refs.

Good technique, accurate source data, and an artistic sense are but some of the prerequisites to the making of a good landform map. It is also necessary to be aware of the effects, individually and collectively, of all factors which have resulted in the terrain as it now exists, and reflect this awareness in the map. For example it is necessary to know whether an area is arid or humid, whether mountains are volcanic, block, or some other type, or whether the streams are youthful, mature, or in some other stage of development.--M. Russell.

3-2902. U. S. Snow, Ice and Permafrost Research Establishment. **BIBLIOGRAPHY ON SNOW, ICE AND PERMAFROST, WITH ABSTRACTS: Its: Sipre Rept. 12, v. 14, 249 p., Jan. 1960, pub. 1961?**

The Bibliography is prepared on a continuing basis by the Science and Technology Division of the Library of Congress under an agreement with the U. S. Army Snow Ice and Permafrost Research Establishment (USA SIPRE) of the Corps of Engineers. The present volume is the fourteenth in the series that began in 1951. Vols. I-V were entitled Annotated Bibliography on Snow Ice and Permafrost. Vols. I-XI were issued semi-annually, but thereafter publication has been annual. Each volume is an indexed cumulation of abstracts issued on standard catalog cards at intervals during the preceding year. Abstracts numbered SIP 17001 through 18000 are included in this volume.

Each entry contains, in addition to an abstract, sufficient descriptive information to identify the original, a symbol designating a library know to have a copy of the original when the abstract was prepared, and the library call number for the original when known. Universal Decimal Classification numbers, based in part on the schedules approved for use in Polar libraries have been added to the abstracts for the first time in this volume.

The primary purpose of the bibliography is to aid USA SIPRE and other government agencies and their contractors concerned with research on snow, ice, and frozen ground.--From introd.

3-2903. Muller, Ernest H. **BIBLIOGRAPHY OF NEW YORK GLACIAL GEOLOGY: A PRELIMINARY COMPILATION: 47 p., Dept. of Geology, Syracuse University, New York, 1960.**

A list of over 750 references on the glacial geology of New York State, including many unpublished theses.--K. M. Clayton (courtesy Geomorphological Abstracts 61/47).

3-2904. Laverdière, Camille, and Albert Courtemanche. **LA GÉOMORPHOLOGIE GLACIAIRE DE LA RÉGION DU MONT TREMBLANT. DEUXIÈME PARTIE. LA RÉGION DE SAINT-FAUSTIN-SAINT-JOVITE [THE GLACIAL GEOMORPHOLOGY OF THE**

MONT TREMBLANT REGION. SECOND PART. THE REGION OF SAINT-FAUSTIN-SAINT JOVITE]: *Cahiers de Géographie de Québec*, v. 5, no. 9, p. 5-32, 11 illus., 8 maps, sec., Oct. 1960-March 1961, 13 refs.; text in French, abs. in English.

Glacial tongues, reaching down from the N. by way of the valleys on both sides of Mont Tremblant, spread out in coalescent lobes in the St. Faustin-St. Jovite bowl, and built up 2 terminal moraines at Sommet. On and around the site of the Provincial Fish Hatchery at St. Faustin, at least 5 ice-dammed lakes were formed between the face of the receding glacier and the natural slope of the ground. The formation of other ice-dammed lakes preceded the establishment of the Rivière Boulé (which had its mouth first at Morrison, then at David sawmill, before settling into its present bed) while the glacial tongue was receding, by phases, from the valley of the Ruisseau des Français. The intermount glacier then caused the retention of 2 large areas of lake water, in which the plain of St. Jovite was formed before these waters receded as far as Lac à l'Équerre, where the melting of the ice provided a relief of fluvioglacial deposits. Finally, the Champlain Sea was able to stretch out a long arm though the valley of the Rivière Rouge and flood the lower valley of the Rivière du Diable where varved clay and sand were deposited.--Auth.

Pt. 1 of this series was listed as GeoScience Abstracts 2-2486.

3-2905. Ives, J. D. **PERMAFROST IN CENTRAL LABRADOR-UNGAVA: Jour. Glaciology**, v. 3, no. 28, p. 789-791, 1960.

Permafrost S. of 55°N. in E. Canada is fairly extensive, reaching a depth of 80 m. locally. Local relief exceeds 300 m. Forest occupies only the more sheltered valleys. Active frost-heave structures occur on the more exposed ground above 680 m., where the mean depth of the widespread permafrost is over 60 m. Areas of snow accumulation are not affected by permafrost, nor does it exist under lichen woodland. It was probably more extensive than now soon after the ice retreated from the area in about 4,000 B.C. Permafrost probably exists on all exposed hill tops down to the Laurentian scarp.--C. A. M. King (courtesy Geomorphological Abstracts 61/78).

3-2906. Shen, Hsieh Wen. **A STUDY ON MEANDERING AND OTHER BED PATTERNS IN STRAIGHT ALLUVIAL CHANNELS: California, Univ., Water Resources Center, Contr. no. 33, 68 p., 19 figs., 5 tables, 1960, 33 refs:**

The purpose of this dissertation is to investigate the meandering and other bed patterns in straight alluvial channels with unerodible banks. The first part of this investigation is devoted to the resistance exerted on the flow by different bed patterns. Many recent experimental data collected by other investigators are analyzed. It is found that with uniform materials, the variation of form resistance due to sand bed irregularities is a function of both the sediment transport rate and the Reynold's number of the sediment particles based on the fall velocity.

The second part of this investigation is devoted to the meandering pattern. Two different types of meandering patterns are found. The first type occurs when the flow is nearly critical with a certain ratio between the width and the depth of flow. This pattern is probably caused by the disturbance of the surface

waves. The second type of meandering with alternating scour holes occurs when water is flowing between rough gravel banks. These alternating scour holes are shown to be caused by a secondary current induced at the intersection between rougher bank and smoother river bed.--Auth.

3-2907. Wolfe, C. Wroe, and Wolfgang V. Swarzenski. THE TECTONIC SIGNIFICANCE OF THE EROSION SURFACES IN NORTHWESTERN MAINE: *Zeitschrift für Geomorphologie*, v. 4, p. 53-68, 1960.

Despite Pleistocene glaciation, 8 erosion surfaces between 750 and 3,300 ft. are recognized in the Blue Mountains of Maine. They are represented by flat valley floors, hillside benches, and flat-topped summits, best developed in porphyritic granite and hornfels. Parallel retreat of slopes and estuarine erosion are cited as important in the development of this flight of surfaces, and a history of periodic uplift interrupted by minor submergences is predicted. This history is attributed to periodic thermal expansion due to warming by radioactivity. A change of state of a subcrustal layer from crystalline to glassy causes each expansion, and recrystallisation afterwards causes some downwards recoil.--J. N. Jennings (courtesy Geomorphological Abstracts 61/29).

3-2908. Thwaites, F. T. EVIDENCES OF DISSECTED EROSION SURFACES IN THE DRIFTLESS AREA: *Wisconsin Acad. Sci., Arts, & Letters, Trans.*, v. 49, p. 17-49, 11 figs., 1960, 59 refs.

The writer has tried to show that every one of the criteria formerly used to demonstrate ancient penplanation of the Driftless Area [upper Mississippi Valley] can be accounted for by another interpretation. The sole possible exception is an apparent bevel of some local structures. The alternative explanations appeal to the writer as more plausible than those formerly offered.

The level skyline is certainly an optical illusion. Beveling of the dolomites is clearly related to the length of time since the protecting strata above were removed, for these are water-soluble formations which were greatly reduced by solution. The upland topography on dolomites displays inverted parabolic slopes in accordance with Gilbert's theory, thus showing mass movement to an extent that makes it impossible to be sure that there is any surviving pre-valley topography.

Cuestas are the dominant feature of the landscape, and examination of the backslopes fails to demonstrate 2 peneplain levels. The cuesta escarpments are sharp youthful topography out of harmony with the idea that they separate peneplains of different ages. The ridge parallel to the Mississippi River which was supposed to connect 2 cuestas is in fact no different from other ridges except that in it the weak St. Peter sandstone is thinner than it is in other localities. Beveling of minor faults and folds by the upland is an uncertain criterion of penplanation because of not only the fallibility of the human eye with such small displacements but also the more rapid erosion of higher places. Happy Hill on quartzite is plausibly accounted for by marine erosion during Ordovician submergence. The terrace which extends the Prairie du Chien upland along the flanks of the quartzite bluffs resembles a marine cliff formed during the deposition of that formation, buried and later exhumed. The plain of central Wisconsin was not used as a line of evidence although it was at one time thought to be a modern undissected peneplain. It actually is a lake

plain. Entrenched (or entrenched) meanders are common in the Driftless Area in medium-sized stream valleys. They appear to indicate uplift, but it is not necessary to assume that they originated on a peneplain. Size of meanders is related to total energy of a stream although flat country fosters development of meanders. The patchy Windrow gravels of the uplands do not prove either a peneplain or a pediplain. These gravels may be as old as Cretaceous. The pediplain hypothesis, although possible, is inadequately supported by the known evidence. The bench on the resistant Franconia sandstone does not show the features of a dolomite upland. It occurs both outside the Prairie du Chien cuesta and in valleys within it in a manner that is wholly out of harmony with the idea of successive uplifts. In accounting for discrepancies between the courses of stream and bedrock structure the simple idea of superposition from formations which are now wholly eroded away appears to have been neglected.

The writer suggests that all the evidence on former penplanation be "stricken from the record as incompetent, irrelevant, and immaterial." If this should be done, we are faced with the choice of either turning to the theory of pediplanation which lacks evidence or returning to Martin's explanation. The latter hypothesis attached more importance to both the nature of the bedrocks and their weathered residuum than was formerly given. It does not deny that possibly, indeed probably, there were many changes in level of sea and land during the long erosional history of the Driftless Area but simply that the evidence of either complete or nearly complete cycles of erosion in this area is not convincing.--Auth. concl.

3-2909. Pierce, Charles. IS SEA LEVEL FALLING OR THE LAND RISING IN S. E. ALASKA?: *Surveying & Mapping*, v. 21, no. 1, p. 51-56, 4 illus., map, table, March 1961, 2 refs.

Twenty portable tide-gage stations were established on Glacier Bay, Chichagof Island, Icy Strait, and Lynn Canal, all of SE. Alaska, during the summer of 1959, and a like number in the adjacent area immediately to the S. during the summer of 1960. In all but one instance these stations were located near tidal bench marks established between 19 and 57 years previously. Records from the first 20 stations installed indicate a relative rise in land levels. The average relative rise per year varies from a low of +.04 ft. in the Cross Sound-Icy Strait area to a high of +.11 ft. in Muir Inlet. Fairly consistent rate-of-change values were obtained for separate areas. Since on most shorelines of the world sea levels have been slowly rising, this local reversal is interpreted as an emerging coastline, probably resulting from the release of load due to melting of the numerous glaciers in the area. Such a rise in land levels will have a pronounced effect upon critical depths in the waterways.--F. D. Shelden.

3-2910. Stalker, Archibald M. BURIED VALLEYS IN CENTRAL AND SOUTHERN ALBERTA: *Canada, Geol. Survey, Paper 60-32*, 13 p., Map 47-1960 (in pocket) scale 1:1,267,200, 1961, 11 refs.

Preglacial and interglacial valleys were studied by following the slopes of the bedrock surface of the old valley walls. The trend of preglacial drainage, generally similar to present drainage, is E. or ENE. At onset of glaciation, drainage was the result of erosion on a slowly rising land surface. In some cases Pleistocene glaciers strongly modified and disrupted preglacial drainage. The greatest disruption was caused

by the Laurentide and corresponding Cordilleran glaciers (of Nebraskan age). On the plains, the over-all effect of the glaciers was to force the rivers to follow more southerly courses. Most of the lasting diversions took place during the retreat of the ice-sheet margin. Since the preglacial rivers took a long time to develop their valleys they are generally broad in shape with sloping sides; the postglacial valleys are

steep-walled and relatively narrow. Added preglacial characteristics are: 1) preglacial "Saskatchewan" gravel and sand, distinctive for its lack of stones from the Precambrian shield; 2) abundance of preglacial Laurentide or Cordilleran till. The buried valleys are of economic significance as potential sources of ground water and for their abundance of good quality gravel.--M. Stewart.

3. STRUCTURAL GEOLOGY

See also: Geophysics 3-2986.

3-2911. Bascom, Willard. A HOLE IN THE BOTTOM OF THE SEA; THE STORY OF THE MOHOLE PROJECT: 352 p., 53 figs., 8 pls., 9 tables, New York, Doubleday, 1961, 48 refs.

This book traces the history of geological thought and attempts to explain how early theories of the earth developed into those presently in fashion by the slow accumulation of data and the testing of ideas over many years. It shows how geological work has expanded and subdivided, tending to become more quantitative and tending toward a closer relationship with the basic sciences of physics, biology, and chemistry, so that now this widened field of effort is called the earth sciences.

The book first describes how indirect investigations are carried out today; how man looks deep inside the earth and backward in time. It then describes how the size and mass and structure of the earth have been worked out, how the composition of the unseen rocks can be estimated, and how the history of the earth has been assembled. It explains how the thickness of the crust is measured and how the best place to drill through it will be located. The final chapters are devoted to modern deep-drilling techniques on land, in shallow water offshore, and in the deep ocean, ending in a description of what the ultimate deep-sea drilling equipment may be like.--From introd.

3-2912. Viktorov, S.V., and others. UTILIZATION OF GEOBOTANICAL INDICATORS IN THE DETECTION OF TECTONIC DISTURBANCES. Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3, no. 6, p. 512-517, 3 figs., June 1961, 7 refs.

The authors describe the method for determining the influence of tectonic disturbances on vegetation and give examples of such influences which were discernible in aerial photographs. In the case of the Sultan-Sadzhar basin, faulting has released ground water which produces a profusion of hydrophytic growth. In southwestern Turkmenia, a vegetation belt has been turned into a "graveyard" by faulting which brought saline waters to the surface. The percentage of dead specimens decreased with the increase of distance from the fault line. District rectilinear belts of solonchak-type vegetation were noted from the air tectonically-disturbed regions of both the above-named regions.--A. Eustus.

3-2913. Shvyryaeva, A.M., and L.M. Starikova. PERSPECTIVES FOR THE UTILIZATION OF GEOBOTANICAL GUIDES IN THE DETECTION OF SALT-DOME STRUCTURES. Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3, no. 6, p. 507-511, map, table, June 1961, 4 refs.

In a hot, dry climate the presence of salt-loving vegetation (halophytes) may serve as a supplementary indicator of the presence of a salt-dome structure. Deep-seated oily water apparently forces the highly saline waters to the surface, where vegetation indicators may take 2 forms: where drainage is poor, the halophytes will be found along the anticline itself, but where drainage is good, they concentrate along the perimeter of the salt-dome structure, sometimes virtually outlining it. In addition, the presence of gigantic and deformed plants in the area may indicate a high bitumen content. However, the influence of the deep oily water on the salinity of overlying deposits, soil, and ground water varies with geologic conditions, depth and chemical composition of the ground water, conditions for its ascendance, and conditions determining soil formation. The authors caution against over-simplification, since not every halophytic association indicates a buried dome; the species composition of the association and presence or absence of bitumen-indicating forms must also be considered.--A. Eustus.

3-2914. Kraev, P.I. NEW DATA ON THE SUB-SURFACE STRUCTURE OF THE EMBA SALT DOMES: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 3-A, p. 151-159, 3 profiles, table, 1959, pub. 1960, 2 refs.

An account is given of the experimental work carried out in the Uralo-Emba region to investigate the morphology of salt bodies and salt domes characterized by buried steep flanks and overhangs. They are difficult to study by ordinary seismic methods, either refraction or reflection, but in-hole seismic exploration shows some promising results. The structural complications of several salt domes are succinctly described and illustrated with diagrammatic cross sections.--C. Voûte.

3-2915. Beloussov, V.V., and E.M. Rudich. ROLE OF ISLAND ARCS IN THE DEVELOPMENT OF THE EARTH'S STRUCTURE. Translated by Research International Associates: Internat. Geology Rev., v. 3, no. 7, p. 557-574, 7 maps, July 1961, 44 refs.

Convincing geological data show that oceanic structure of the earth's crust is secondary and formed as the result of destruction and basification of the continental crust. This process goes on under conditions of tension, of deep fault formation, and of strong basaltic volcanism.

Analysis of the structure and history of development of island arcs gives evidence enough to distinguish 2 types. Island arcs of the first type represent arching folded ranges, similar to continental folded arcs. They were formed in geosynclines, but in the process of basification the supporting interior massifs subsided, while the arcs themselves are preserved in the form of curved bands of the continental

crust within the oceanized areas (Japan, Indonesia, the Antilles). During a process involving tension of the earth's crust these weakened geosynclinal zones became areas of large fracture formation initiating intensive volcanism.

Arcs belonging to the second type are not related to the previous geosynclinal development. They were formed as a direct result of tension of the earth's crust, in the environment of ocean development. The tension produced deep faults, and the curving of the trajectories of the tensional stresses in the process of fault growth gave rise to the arching of these faults. Being younger, arcs of the second type cross those of the first type.

The asymmetry of the Pacific Ocean is characterized by the fact that on the E. the ocean is bordered by the Cordilleras and the Andes, forming a single weak zone, while on the western periphery of the ocean the crust resembles a mosaic with very heterogeneous structure.

Basification of the earth's crust and formation of oceans is the last known stage in the development of the earth, caused by radioactive heating of the earth's interior and subsequent smelting to the surface of the deep material of the mantle.--Auth. English summ.

3-2916. Schmeck, Harold M. Jr. DEEP-CRUST

ROCK TAKEN FROM SEA: New York Times, v. 110, no. 37,788, p. 23, col. 8, p. 37, col. 2, map, July 10, 1961.

Samples of rock from the "third layer," that layer believed to lie directly above the Mohorovičić discontinuity, have been dredged from the N. wall of the Puerto Rico trench in water more than 7 km. deep by the Woods Hole Oceanographic Institution's research vessel Chain. The samples are of an extremely dense, ultrabasic, light green rock.--M. Russell.

3-2917. Hill, Patrick Arthur. STRUCTURAL HISTORY OF THE BEAVERLODGE AREA: Econ. Geology, v. 56, no. 3, p. 614-617, 2 maps, May 1961, 7 refs.

Second discussion by Hill (see also GeoScience Abstracts 2-311) of a paper by J.A. Chamberlain (GeoScience Abstracts 1-1377). Chamberlain has written a structural history [of this area of Saskatchewan] that omits consideration of certain faults showing movements on the order of 1,000 ft. as well as other features such as the concentric structures of Martin Lake, the Milliken Lake antiform, the intrusive(?) and nonintrusive (?) quartzites, etc.--J. A. Chamberlain.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Geologic Maps 3-2880, 3-2881; Areal and Regional Geology 3-2898, 3-2899; Paleontology 3-2951, 3-2953; Geochemistry 3-3035, 3-3036, 3-3052; Fuels 3-3146, 3-3149, 3-3150.

3-2918. Skillman, Margaret W. HISTORICAL GEOLOGY LABORATORY MANUAL. Revised by Victor Brown Monnett: 2d ed., 143p., 80 figs. incl. illus., maps, secs., diags., Minneapolis, Burgess Publishing Company, 1960.

Many excellent historical geology laboratory manuals are available. Most of these were designed to be used at a specific school and were based upon the fossils and geologic maps available at that particular institution. The success of the first edition of this manual was due largely to its complete independence from specific fossils and geologic maps. This manual is sufficiently comprehensive and self-contained so that an instructor may select a normal semester's sequence of laboratory exercises with no extra required materials other than a textbook on historical geology. A copy of the geologic map of the United States should be made available to the students, but even this map is not essential.

Although some of the material in the original edition has been deleted, there remains an excess of exercises for a one-semester course. It is intended that all instructors will require students to work the exercises on biologic classification and those concerned with outcrop patterns and structure sections for these are prerequisite to an understanding of other exercises in the manual. Beyond these basic requirements, the instructor has a choice of selecting and varying the work each semester.--From foreword.

The 4 major sections of the manual cover paleontology, sedimentation and stratigraphy, map interpretation, and historical geology.

3-2919. Carlson, Clarence G. STRATIGRAPHY OF THE WINNIPEG AND DEADWOOD FORMATIONS

IN NORTH DAKOTA: North Dakota, Geol. Survey, Bull. 35, 149 p., 17 figs. incl. maps, secs., 2 pls., 2 tables (1 in pocket), 1960, 98 refs.

The Deadwood formation includes all of the pre-Winnipeg sedimentary rocks of North Dakota, which range in thickness from an erosional edge in the subsurface of eastern North Dakota to at least 1,000 feet in northwestern North Dakota. It is composed of sandstone, shale, and carbonates of Late Cambrian to Early Ordovician age. Wells which have penetrated complete sections of the Deadwood formation are limited to the eastern half of North Dakota with the exception of a few wells in northwestern North Dakota and a few wells near the borders of the state in adjacent states and provinces. Therefore, facies relationships are not entirely clear, but sedimentation appears to have been continuous from Late Cambrian to Early Ordovician time, so a further division of the pre-Winnipeg sedimentary rocks into Late Cambrian and Early Ordovician formations, thus restricting the Deadwood formation to rocks of Late Cambrian age, is not feasible.

Conodonts were obtained from the upper part of the Deadwood formation from 3 wells in northwestern North Dakota. These conodonts are brownish-black in color, rather than the usual amber color, and are mostly simple cone types (Distacodidae), although a few compound forms such as *Coleodus simplex* Branson and Mehl and *Neocoleodus* sp. are also present. This fauna is not closely allied to any previously described fauna, but it is probably of Early Ordovician age based on the predominance of the Distacodidae.

The Winnipeg formation consists of sandstone, shale, and siltstone, which range in thickness from an erosional edge in the subsurface of southeastern North Dakota to a maximum of 357 ft. in northwestern North Dakota. The Winnipeg lies unconformably on the Deadwood formation except in northwestern North Dakota, where it may lie conformably on the Deadwood formation, and in northeastern North Dakota, where it lies unconformably on Pre-

cambrian rocks. It is overlain conformably by the Red River formation.

The Winnipeg formation is divided into 3 members which are, in ascending order: 1) Black Island member, composed of very fine to medium-grained, clean, quartzose sandstone; 2) Icebox member, composed of greenish-gray, noncalcareous shale; and 3) Roughlock member, composed of light greenish-gray to very light gray, calcareous siltstone, very fine grained sandstone, and calcareous shale.

The Winnipeg formation is Middle Ordovician in age, based on comparisons of the conodont fauna of the Winnipeg formation to Middle and Late Ordovician conodont faunas of the Upper Mississippi Valley. These comparisons show that the lower part of the Icebox member contains a fauna similar to the Glenwood formation, the middle and upper part of the Icebox member contain a fauna similar to the Decorah formation, and the Roughlock fauna resembles the Decorah fauna more closely than that of the Galena formation. Therefore, the Black Island member is probably Chazyan, the Icebox member is Blackriveran to lower Trentonian, and the Roughlock member is Trentonian.--Auth.

3-2920. Maehl, Richard H. THE OLDER PALAEOZOIC OF PICTOU COUNTY, NOVA SCOTIA (WITH GEOLOGICAL PLAN AND SECTIONS): Nova Scotia, Dept. Mines, Mem. no. 4, 110 p., 6 figs. (3 in pocket, incl. map, secs.), 17 tables, 1961, 56 refs. (not seen at AGI).

In eastern Pictou County a sequence of at least 15,000 ft. of lower Devonian, Silurian, and pre-Silurian sedimentary and volcanic rocks are overlain unconformably by rocks of the Mississippian Windsor group. The older Paleozoic succession is exposed in a broad anticlinal structure plunging to the W. The predominantly volcanic pre-Silurian Browns Mountain group is at least 10,000 ft. thick and displays 2 areas of flows surrounded by water-laid tuffs and tuffaceous sandstones. In the northern part of the area studied, the Silurian is represented by a succession similar to the Arisaig series of Antigonish County to the E. This sequence is composed of mudstones and argillaceous sandstones of a marine shelly facies. To the S., quartzites and black shales are present, marking a lithologic transition to the quartzites and black slates of a graptolitic facies observed in the Annapolis Valley to the SW. The facies distribution indicates an E.-W. linear basin of deposition, with the shallow-water beds of the marine shelly facies to the N. Ripple marks and small scale cross-bedding reveal that currents flowed from the NW, and the distribution of some ash and tuff beds suggests a source to the NE. The lower Devonian is represented by a red-bed sequence in eastern Pictou County and by a marine shelly facies in the Annapolis Valley, indicating widespread shallowing and emergence of the sedimentary basin. The fine-grained sedimentary rocks have developed cleavage in places and compositionally are treated as low-grade metamorphics. The major minerals present are quartz, muscovite, chlorite, albite, and orthoclase or kaolinite.--J. P. Nowlan.

3-2921. Harker, Peter. SUMMARY ACCOUNT OF CARBONIFEROUS AND PERMIAN FORMATIONS, SOUTHWESTERN DISTRICT OF MACKENZIE: Canada, Geol. Survey, Paper 61-1, 9 p., 1961, 5 refs.

Carboniferous and Permian strata in southern Mac-

kenzie Mountains have already been briefly described in other Geological Survey of Canada preliminary maps and reports using numbered map-units. This report proposes formal names for 5 new formations: Yohin, Clausen, Flett, Etanda, and Fantasque. Faunal lists, summary of lithology, and indication of type locality are given for each formation. In the eastern part of the succession shale and limestone are found; carbonate decreases westward, and the sequence becomes mainly shale and sandstone. Contact with the underlying Devonian is difficult to determine. The western sequence is assigned to the Etanda formation, a facies equivalent of the Flett, Clausen, and Yohin formations.--M. Stewart.

3-2922. Gonta, E. T. PALEOGEOGRAPHY OF THE CARBONIFEROUS SEDIMENTS OF THE DNIEPER-DONETS DEPRESSION, THE NORTH AND NORTH-WEST MARGINS OF THE DONETS BASIN: *Geologiya i Nefti - Petroleum Geology*, in translation, v. 3, no. 3-A, p. 167-175, 5 maps, 1959, pub. 1960, 10 refs.

The sediments of the Carboniferous show an irregular distribution and variations in thickness and composition in the general area of the Donets basin and in the regions bordering it on the NW. and extending into Belorussia. Several transgressions occurred, locally alternated by periods of erosion and of weathering. The area as a whole formed a single geotectonic unit, not divided by tectonic barriers. The distribution of various sediments during the different stages of the Carboniferous is indicated, and mention is made of a large number of transgressions and regressions. Several successive shorelines and transition zones between land and sea are sketched. It is concluded that conditions were favorable for bitumen formation during the Tournasian stage and for coal accumulation during late Visean time.--C. Voûte.

3-2923. Allsopp, H. L. Rb-Sr AGE MEASUREMENTS ON TOTAL ROCK AND SEPARATED-MINERAL FRACTIONS FROM THE OLD GRANITE OF THE CENTRAL TRANSVAAL: *Jour. Geophys. Research*, v. 66, no. 5, p. 1499-1508, 2 figs., 4 tables, May 1961, 11 refs.

The ages here reported relate to the Old Granite that is exposed between Johannesburg and Pretoria in the Transvaal. The Rb-Sr method was used to measure the ages of 5 total-rock samples and 13 mineral fractions separated from the granite and from pegmatite veins. The chemical and mass-spectrometric techniques employed are described briefly. The total-rock samples yield concordant results, and the age of emplacement of the granite is found to be $3,200 \pm 65$ m. y. ($\lambda = 1.39 \times 10^{-11}$ years⁻¹), while the primary abundance of Sr⁸⁷ is found to be .07006 \pm .00030. The apparent age as deduced from the separated minerals vary widely, and ages both higher and lower than the total-rock age are reported. It is considered that the discordance of the mineral ages is the result of the diffusion of radiogenic Sr from mineral to mineral and that the diffusion probably occurred about 2,000 m. y. ago.--Auth.

3-2924. Nicolaysen, L. O., and others. AGE MEASUREMENTS ON PEGMATITES AND A BASIC CHARNOKITE LENS OCCURRING NEAR LÜTZOW-HOLM BAY, ANTARCTICA: *Geochim. et Cosmochim. Acta*, v. 22, no. 2-4, p. 94-98, map, 2 tables, March 1961, 13 refs.

Rb⁸⁷-Sr⁸⁷ age measurements were carried out on large biotite crystals from 3 granitic pegmatites and a basic charnockite lens occurring near Lützow-Holm Bay, Queen Maud Land. The mean age obtained (~515 million years) probably refers to the last major metamorphic episode in this region. The age data are also significant for the interpretation of paleomagnetic results reported from this area.--A. C. Sangree.

3-2925. Tugarinov, A.I., and others. THE AGE OF THE OLDEST ROCKS OF ANTARCTICA: Geokhimiya, in translation, 1959, no. 6, p. 676-678, 2 tables, pub. 1961, ref.

The age determination of allanite by the Pb-U-Th method and of biotite and muscovite by the K-Ar method gave very similar results, indicating magmatic activity in this part of Antarctica about 1,300 million years ago. The most probable age of the minerals is 1,300 ± 100 million years.-- M. Russell.

3-2926. Anderson, Sidney B. SUMMARY OF THE PEMBINA MOUNTAIN OIL EXPLORATION COMPANY - ISAAC AKRE NO.1, WALSH COUNTY, NORTH DAKOTA, WELL NO. 2078 - PERMIT NO. 2090: North Dakota, Geol. Survey, Circ. no. 240, 3 p., Jan. 1961.

Description of samples and core chips from well spudded Oct. 1958 and abandoned Apr. 1959 at 1,765 ft. Ordovician, Silurian, and Jurassic formations were penetrated.--A. C. Sangree.

3-2927. Carlson, Clarence G. SUMMARY OF THE AMERADA PETROLEUM CORPORATION - C. C. MOGEN TRACT 1, NO. 1, MCKENZIE COUNTY, NORTH DAKOTA, WELL NO. 1670 - PERMIT NO. 1691: North Dakota, Geol. Survey, Circ. no. 241, 13 p., Aug. 1960.

Description of samples and core chips from well spudded Dec. 1957, drilled to total depth of 11,887 ft.,

and completed as a discovery well for the Sand Creek field, June 1, 1958. Silurian, Devonian, Mississippian, Permian, Triassic, Jurassic, and Cretaceous formations were penetrated.--A. C. Sangree.

3-2928. Carlson, Clarence G. SUMMARY OF THE AMERADA PETROLEUM CORPORATION, HUNT OIL COMPANY - PEDERSON, CATER UNIT NO. 1, WILLIAMS COUNTY, NORTH DAKOTA, WELL NO. 2182 - PERMIT NO. 2194: North Dakota, Geol. Survey, Circ. no. 242, 8 p., Jan. 1961.

Description of samples and core chips from well spudded Feb. 1959, drilled to total depth of 10,441 ft. and abandoned as noncommercial in Apr. 1959. Well was reworked in Oct. 1959 and completed as a producing well in Nov. 1959. Devonian, Mississippian, Triassic, Jurassic, and Cretaceous formations were penetrated.--A. C. Sangree.

3-2929. Eastwood, William P. SUMMARY OF THE PHILLIPS PETROLEUM CO. - GLENN BRANDT #1, BOTTINEAU COUNTY, NORTH DAKOTA, WELL NO. 2596 - PERMIT NO. 2608: North Dakota, Geol. Survey, Circ. no. 243, 5 p., Jan. 1961.

Description of samples and core chips from well drilled to total depth of 6248 ft., Feb.-Apr. 1960, and abandoned as a dry hole. Silurian, Devonian, Mississippian, Triassic, and Cretaceous formations were penetrated.--A. C. Sangree.

3-2930. Eastwood, William P. SUMMARY OF PHILLIPS PETROLEUM CO. - BRANDVOLD #1, BOTTINEAU CO., NORTH DAKOTA, WELL NO. 2638 - PERMIT NO. 2650: North Dakota, Geol. Survey, Circ. no. 244, 7 p., Jan. 1961.

Description of samples and core chips from well spudded Apr. 1960, drilled to 5,250 ft. and abandoned May 1960. Silurian, Devonian, Mississippian, Triassic, and Cretaceous formations were penetrated.--A. C. Sangree.

5. PALEONTOLOGY

3-2931. Dodson, Edward O. EVOLUTION: PROCESS AND PRODUCT: 352 p., 113 figs. incl. illus., maps, diags., 3 tables, New York, Reinhold Publishing Corp., 1960, refs.

A revision of A Textbook of Evolution, published in 1952. The general organization of the first edition has been retained. Pt. 1 includes 7 chapters, summarizing the contents of the older books on evolution, and serving primarily to define the subject. These chapters present the major evidences for evolution. A new chapter, on evidence from comparative physiology and comparative biochemistry, has been added. Pt. II, Phylogeny, deals with the evolution of the higher categories and attempts to trace the main lines of evolution in the plant and animal kingdoms, including the probable lineage of man. Pt. III, the Origin of Variation, deals with the mode of origin of those hereditary variations which form the necessary substrate for the action of natural selection. Pt. IV, the Origin of Species, deals with those factors which sort out the varying arrays of organisms into species, genera, and higher groups. A new chapter on quantitative aspects of evolution has been added here. Lastly, Pt. V, Retrospect and Prospect, summarizes briefly what has gone before,

attempts to put it in perspective, and brings together some predictions of bolder scientists as to what future evolution may bring.--From auth. pref.

3-2932. Tax, Sol, ed. EVOLUTION AFTER DARWIN: 3 v., illus., Chicago, University of Chicago Press, 1960, refs.

Each volume in this 3-volume work contains a series of papers by various authors. Vol. 1, "The Evolution of Life," contains an introduction to Charles Darwin and to evolution; a review, from several disciplines, of the present state of knowledge of the origin and history of life; and an analysis of the processes governing growth and change.

Vol. 2, "The Evolution of Man," opens with an introduction to the human phase of evolution. Several papers trace the emergence of Homo sapiens and the gradual development of civilization. Five essays are devoted to the nature of behavior and mental activity. The volume then returns to its consideration of man's unique psychological development and his control, through society and culture, of himself and his destiny.

Vol. 3, "Issues in Evolution," contains a small group of papers concerned with the relationship be-

tween science and spiritual values; the record of the University of Chicago Darwin Centennial Celebration itself, including the discussions; and an index to all 3 volumes.--L. M. Dane.

3-2933. Ross, June R. P. Phillips. LARGER CRYPTOSTOME BRYOZOA OF THE ORDOVICIAN AND SILURIAN, ANTICOSTI ISLAND, CANADA - PART II: Jour. Paleontology, v. 35, no. 2, p. 331-344, 5 pls., 7 tables, March 1961, 20 refs.

Valid species of larger cryptostome Bryozoa of the genera *Phaenopora*, *Stictopora*, and *Pachydictya* in late Ordovician and early and middle Silurian strata of Anticosti Island may be conveniently assigned to 3 informal categories: *Phaenopora superba* Billings to the escharoporid group; *Stictopora* sp. A to the stictoporid group; and *Pachydictya ambigua* (n. sp.) to the pachydictyid group. Restudy of the original material and additional specimens of the type species of *Phaenopora*, *P. explanata* Hall, indicate its morphological similarity to *Stictoporella*.

Reexamination of the type species of *Hemidictya*, *H. lebanonensis* Coryell, reveals that this genus, like *Rhinidictya*, is a synonym of *Stictopora*.--Auth.

3-2934. Hughes, R. J. Jr. NEMOCARDIUM NICOLLETTI FROM THE PALEOCENE MATTHEWS LANDING MARL IN MISSISSIPPI: Jour. Paleontology, v. 35, no. 2, p. 385-390, fig., pl., table, March 1961, 13 refs.

Pelecypods, variously called as time went on, *Cardium*, then *Protocardia*, and then *Nemocardium*, have been described and figured from localities in the Gulf Coastal Plain since 1854. In the present article, for the first time, a specimen of *Nemocardium nicolletti* (Conrad) from Mississippi, found in the Matthews Landing marl member of the Porters Creek clay of Paleocene age, is identified and described. This *N. nicolletti* is compared with specimens from the Matthews Landing marl, Marengo County, Alabama, and at Naheola Landing, on the Tombigbee River, Choctaw County, Alabama. *N. nicolletti* ranges from supposed middle Eocene down into the Paleocene. No Tertiary species are now referred to the genus *Protocardia*. All Tertiary species, including *N. nicolletti* once referred to the genus *Protocardia* are now considered to belong under the genus *Nemocardium* Meek.--Auth.

3-2935. Teichert, Curt, and Bernhard Kummel. SIZE OF ENDOCEROID CEPHALOPODS: *Breviora*, no. 128, 7 p., illus., Dec. 1960, 13 refs.

The physical and deductive evidence on the maximum size of cephalopods is reviewed. The largest fragment on display (Harvard) of *Endoceras* is 3,000 mm. long; a complete reconstruction would total over 8,000 mm. The largest modern invertebrate is *Architeuthis harveyi*? with a maximum recorded length of 17 m.--M. Russell.

3-2936. Unklesbay, A. G. NAUTILOIDS FROM THE GORMAN AND HONEYCUT OF CENTRAL TEXAS: Jour. Paleontology, v. 35, no. 2, p. 373-379, fig., 2 pls., March 1961, 9 refs.

This paper presents descriptions of 6 species of nautiloids from the Honeycut [Ordovician] and 1 from the Gorman [Ordovician] of central Texas. Of these 6, 4 are known from the Jefferson City of Missouri, and 2 from the Cotter-Powell. The Gorman species

is also known from the Gasconade of Missouri. One new species, *Stylocyrtoceras annulatum*, is described from the Honeycut.--Auth.

3-2937. Kummel, Bernhard. THE SPITSBERGEN ARCTOCERATIDS: Harvard Univ., Mus. Comp. Zoology, Bull., v. 123, no. 9, p. 499-532, 5 figs., 9 pls., March 1961, 51 refs.

A total of 7 species of *Arctoceras* from the lower Triassic Posidonomya beds of Spitsbergen have previously been described. A reexamination was made of most of the primary types of each of the species, plus a number of additional specimens. The conclusion of this study is that the Posidonomya beds of Spitsbergen contain only one species of *Arctoceras*, namely *A. blomstrandii* (Lindström). All the remaining species are either immature forms or morphological variants of a variable species group. In addition, it is concluded that the *Arctoceras* fauna of Spitsbergen is more likely mid-Scythian in age (Owenitan division of Spath) than late Scythian (Columbitan or Prohungaritan of Spath) as believed by most previous authors.--From auth. introd.

3-2938. McCrady, Allen D. PROSPECTING LIMESTONE AREAS FOR PLEISTOCENE VERTEBRATE FOSSILS: Soc. Vertebrate Paleontology, News Bull. no. 60, p. 30-33, 2 figs., Oct. 1960.

Caves in limestone regions prove to be good sites for collecting fossil vertebrates of Pleistocene age. A description is given of the type of cave most likely to have fossil bone, and the best area for prospecting within a cave.--N. E. Wright.

3-2939. Redden, Jack A. FOSSIL BEAR DISCOVERED: Mineral Industries Jour., v. 8, no. 1, p. 5, March 1961.

The skeleton of a modern black bear was enclosed in cave filling consisting of fragments of marble and other metamorphic rocks in the James River marble belt about 10 mi. sw of Altavista, Virginia. Tentative age is several thousand years; exact dating would make it possible to determine the rate of downcutting of the Roanoke River.--M. Russell.

3-2940. Bramlette, M. N., and F. R. Sullivan. COCCOLITHOPHORIDS AND RELATED NANNOPLANKTON OF THE EARLY TERTIARY IN CALIFORNIA: Micropaleontology, v. 7, no. 2, p. 129-188, fig., 14 pls., table, Apr. 1961, 45 refs.

Evidence of the stratigraphic value of the fossil remains of an abundant and varied calcareous nannoplankton has been limited by little published data. Description of the species and tabulated distributions in 86 samples from a continuous sequence of Paleocene and Eocene strata of California permit recognition of 6 distinct biostratigraphic units. Available evidence on their extension as zones elsewhere and relations to type areas of some European stages are presented.--Auth.

3-2941. Evitt, William R. THE DINOFLAGELLATE NANNOCERATOPSIS DEFLANDRE: MORPHOLOGY, AFFINITIES AND INFRASPECIFIC VARIABILITY: Micropaleontology, v. 7, no. 3, p. 305-316, 17 figs., 2 pls., July 1961, 21 refs.

A reinterpretation of the morphology of *Nanno-*

ceratopsis Deflandre 1938 is based on a study of many specimens of *N. deflandrei* Evitt n. sp. from the Lower Jurassic (Lias δ) of Denmark - the first dinoflagellate to be described from the Lower Jurassic. *Nannoceratopsis* is morphologically similar to Recent *Dinophysiales*, a group of dinoflagellates without a previously reported fossil record. The extreme infraspecific variability of the new species is analysed. Discovery of *N. pellucida* Deflandre, the type species, in the Upper Jurassic of Utah provides the first record of the genus in North America. -- Auth.

3-2942. Loeblich, Alfred R., Jr., and Helen Tappan. SUPRAGENERIC CLASSIFICATION OF THE RHIZOPODEA: Jour. Paleontology, v. 35, no. 2, p. 245-330, March 1961, 368 refs.

A proposed suprageneric classification of the class Rhizopodea is given, with particular revision of the order Foraminiferida. For each category of the proposed classification a complete synonymy is attempted, including family group names originally proposed as new, variant spellings, emended terminations and transfers from one family group status to another, all with full references.

The subclass Lobosia contains the orders Amoebida and Arcellinida (each with 2 superfamilies) and Mycetozoida (with 3 suborders). The subclass Filosia includes the orders Aconchulinida and Gromida (the latter with 2 superfamilies), and the subclass Granuloreticulosa contains the orders Athalamida, Monothalamida and Foraminiferida (with 17 superfamilies, based on the test wall composition and structure), Xenophyophorida, and Proteomyxida.

New family group names proposed herein are the families Pocheinae, Penardiidae, and Biomyxidae, and subfamilies Dianemininae, Tawitawinae, Pavonitinae, Umbellinae, Stacheinae, Cyclogyrinae, Lingulinae, Oolininae, Hedbergellinae, Truncotaloidinae, Rupertinae, and Fursenkoininae.

Corrected names herein are the subclass Lobosia (pro Lobosa), order Xenophyophorida (pro Xenophyophora), suborder Sorophorina (pro Sorophora), superfamilies Ceratiomyxacea (pro Ceratiomyxioidea), Stemonitacea (pro Stemonitididae), Trichiacea (pro Trichiidae), Gromiacea (pro Gromiidae), Lagynacea (pro Lagynidea), Ammodiscacea (pro Ammodiscoidea), Lituolacea (pro Lituolidea), Parathuraminacea (pro Parathuraminidea), Endothyraea, (pro Endothyridea), Fusulinacea (pro Fusulinoidea), Miliolacea (pro Miliolidea), Nodosariacea (pro Nodosariidea), Buliminacea (pro Buliminidea), Rotaliacea (pro Rotaliidea), Globigerinacea (pro Globigerinidea), Orbitoidacea (pro Orbitoididea) and Spirillinacea (pro Spirillinidea); family Plasmodiophoridae (pro Plasmodiophoreae), subfamilies Physariinae (pro Physarei), Didymiinae (pro Didymiei), Stemonitinae (pro Stemonitei), Trichiinae (pro Trichiei), Arcyriinae (pro Arcyrie), Loftusiinae (pro Loftusinae), Loeblichinae (pro Loeblichinae), Discospirinae (pro Discospirillinae), Glandulininae (pro Glandulineae), Fabulariinae (pro Fabulariacea) and Pleurostomellinae (pro Pleurostomellidae).

Names which have been corrected and elevated in rank (nom. transl.) include the subclasses Filosia (ex order Filosia) and Granuloreticulosa (ex order Granuloreticulosa).

Family group names which have been elevated or lowered in rank (nom. transl.) include the following superfamilies elevated from family status: Pelomyxacea (ex Polomyxidae), Tetramitacea (ex Tetramitidae), Arcellacea (ex Arcellidae), Cryptodifflu-

giacea (ex Cryptodifflugidae), Euglyphacea (ex Euglyphidae), Diplophyrea (ex Diplophyridae), Asterigerinacea (ex Asterigerinidae), Cassidulinacea (ex Cassidulinidae), Robertinacea (ex Robertinidae) and Carterinacea (ex Carterinidae). Families elevated from subfamily status include the Paraquadridae (ex Paraquadridinae), Botellinidae (ex Botellininae), Nouridae (ex Nourinae), Moravaminidae (ex Moravamininae), Colaniellidae (ex Colaniellinae), Turritinidae (ex Turritininae), Sphaeroidinidae (ex Sphaeroidininae), Bolivinitidae (ex Bolivinitinae), Eouvigerinidae (ex Eouvigerininae), and Caucasinidae (ex Caucasininae). Subfamilies lowered from family or tribe status herein include the Colodermatinae (ex Colodermaceae), Amaurochaetinae (ex Amaurochaetaceae), Cribariinae (ex Cribariaceae), Liceinae (ex Liceoidei), Tubiferinae (ex Tubiferae), Reticulariinae (ex Reticulariaceae), Lycogalinae (ex Lycogalaceae), Ventrolamininae (ex Ventrolaminidae), Barkerininae (ex Barkerinidae), Tuberitinae (ex Tuberinidae), Nodosinellinae (ex Nodosinellidae), Pitchocladinae (ex Ptychocladidae), Enantiomorphininae (ex Enantiomorphinidae), Gavelinellinae (ex Gavelinellidae) and Epistomininae (ex Epistominidae).

Five new generic names are proposed to replace homonyms on which family group names had been based: Pocheina (pro Guttulina Cienkowski 1873, non Guttulina d'Orbigny, 1839), Dianemina (pro Dianema Rex 1891, non Dianema Cope, 1871), Umbellina (pro Umbella Maslov, 1955, non Umbella d'Orbigny, 1841), Rupertina (pro Rupertia Wallich, 1877, non Rupertia Gray, 1865), and Fursenkoina (pro Virgulina d'Orbigny, 1826, non Virgulina Bory de St. Vincent, 1823). -- Auth.

3-2943. Loeblich, Alfred R., Jr., and Helen Tappan. THE STATUS OF THE FORAMINIFERAL GENERA AMMODISCUS REUSS, AND INVOLUTINA TERQUEM: Micropaleontology, v. 7, no. 2, p. 189-192, Apr. 1961, 22 refs.

The status of the genera Ammodiscus Reuss, 1862, and Involutina Terquem, 1862, is discussed on the basis of their revision by Bornemann, 1874, and Loeblich and Tappan, 1954. Ammodiscus Reuss is retained for agglutinated planispiral evolute species, similar to the type species Ammodiscus infimus Bornemann, 1874 (not Strickland, 1846) = Ammodiscus siliceus (Terquem), 1862. Involutina Terquem is restricted to those planispiral calcareous species, with lateral umbilical filling, similar to the type species Involutina jonesi Terquem and Piette (1862) = Involutina liasina (Jones), 1853. -- Auth.

3-2944. Loeblich, Alfred R., Jr. CRETACEOUS PLANKTONIC FORAMINIFERA: PART I - CENOMANIAN: Micropaleontology, v. 7, no. 3, p. 257-304, 8 pls., July 1961, 75 refs.

Twenty-seven Cenomanian planktonic foraminiferal species are described and some 60 specific names included in their synonymy. These species are from North America, Europe, and an Atlantic core N. of the Bahama Islands. Evidence of the planktonic Foraminifera suggests a Cenomanian (rather than Turonian) age for the N. Texas Eagle Ford group, an Eagle Ford (rather than Woodbine) age of the entire eastern Gulf subsurface Atkinson formation, and a mid to late Cenomanian (rather than Albian or early Cenomanian) age for the "Franciscan" strata at New Almaden, California.

The family Rotaliporidae Sigal 1958, is recognized

as distinct from the Globorotaliidae, and has been enlarged to include the subfamilies Hedbergellinae and Rotaliporinae. The Rotaliporidae have a geologic range from Hauterivian to Maestrichtian. The Planomalinae Bolli, Loeblich and Tappan is recognized as of family rank, having been elevated from subfamily status by Sigal (1958), and the family Schackoinidae Pokorný, 1958, is also recognized as distinct from the Hantkeninidae and has a geologic range from Aptian to Maestrichtian. The Globorotaliidae and Hantkeninidae thus are of Cenozoic occurrence.--Auth.

3-2945. Watkins, James G. FORAMINIFERAL ECOLOGY AROUND THE ORANGE COUNTY, CALIFORNIA, OCEAN SEWER OUTFALL: Micropaleontology, v. 7, no. 2, p. 199-206, 7 figs., 2 tables, Apr. 1961, 26 refs.

One hundred and twenty bottom samples were collected from 24 stations surrounding the Orange County ocean sewer outfall. Two zones of depth distribution were determined; an intertidal zone from 0 to 20 ft. and an upper sublittoral zone from 20 to 78 ft. The manner in which the effects produced by the outfall influence the Foraminifera is discussed.--Auth.

3-2946. Tasch, Paul, and Bernard L. Schaffer, STUDY OF SCOLECODONTS BY TRANSMITTED LIGHT: Micropaleontology, v. 7, no. 3, p. 369-371, pl., July 1961, 2 refs.

A technique in the preparation of scolecodonts for study under the microscope is described. Possible application of this technique in the study of other microfossils is indicated.--Auth.

3-2947. Ash, Sidney R. BIBLIOGRAPHY AND INDEX OF CONODONTS, 1949-1958: Micropaleontology, v. 7, no. 2, p. 213-244, fig., table, Apr. 1961.

Three hundred and sixty-one published articles and 42 theses and dissertations that concern or mention conodonts are listed. Four hundred and ninety new forms including 41 new genera and 421 new species are described in the published articles. Conodonts are now known to range from Late Cambrian through Late Triassic time and possibly into Late Cretaceous time. They have been reported found in 31 countries.--Auth.

3-2948. Tasch, Paul. EVALUATION OF FOUR "NEW" LEAID CONCHOSTRACAN GENERA: Jour. Paleontology, v. 35, no. 2, p. 380-384, pl., March 1961, 6 refs.

The apparent leaoid *Monoleaia karagandica* Miro. 1956 bears a single anterior costa that does not cross the umbo and is therefore reassigned to the genus *Monoleiopholus*, family *Estheriellidae*. To accommodate *estheriellids* bearing 1 to 4 costa a new subfamily is proposed, *Karagandiinae*.

Troisleaia Miro. 1956 does not differ importantly from *Paraleaia* and is reassigned to that genus.

Teixeirium Nov. 1958 appears to be based on dubious material. If the genus bears the interpreted morphology, its preferred assignment would be under the new subfamily *Karagandiinae*.

Fernandoalmeidium Nov. 1958 is inadequately documented, since the inferred morphology cannot be derived from the photograph of the type specimen.--Auth.

3-2949. Swain, Frederick M., and others. OSTROCODA OF THE FAMILIES APARCHITIDAE, AEC-

MINIDAE, LEPERDITELLIDAE, DREPANELLIDAE, EURYCHILINIDAE AND PUNCTAPARCHITIDAE FROM THE DECORAH SHALE OF MINNESOTA: Jour. Paleontology, v. 35, no. 2, p. 345-372, 2 figs., 5 pls., table, March 1961, 24 refs.

Ostracoda representing 30 species distributed in 12 genera are described from the Decorah shale [Ordovician] of Minnesota. Five of the species, 4 of the genera, and 1 family are newly described as follows: 1. *Aparchitidae*-*Bullatella granilabiata* (Ulrich) Swain & Cornell, n. gen.; 2. *Leperditellidae*-*Pedomphalella intermedia* Swain & Cornell, n. gen., n. sp., *P. subovata* Swain & Cornell, n. sp., *Byrsolopsina planilateralis* (Kay) Swain & Cornell, n. gen., *Byrsolopsina nodambichilina* Swain & Cornell, n. sp.; 3. *Eurychilinae*-*Nodambichilina symmetrica* (Ulrich) Swain & Cornell, n. gen., *Tsitrella simplex* Swain & Hansen, n. sp.; 4. *Punctaparchitidae* Swain, Cornell & Hansen, n. fam. The latter family is believed to be an early representative of the Cytheracea.

Byrsolopsina planilateralis (Kay) and associated species form a zone in the middle Decorah of Minnesota, and *Nodambichilina symmetrica* (Ulrich) forms a subzone in the upper part of the *B. planilateralis* zone.--Auth.

3-2950. Levinson, Stuart A. NEW GENERA AND SPECIES OF BROMIDE (MIDDLE ORDOVICIAN) OSTROCODES OF OKLAHOMA: Micropaleontology, v. 7, no. 3, p. 359-364, pl., table, July 1961, 3 refs.

Two new genera and 5 new species of ostracodes are described from the Middle Ordovician Bromide formation of Oklahoma. Distinctive dimorphism in these forms is also discussed.--Auth.

3-2951. Pessagno, Emile A., Jr. THE MICROPALAEONTOLOGY AND BIOSTRATIGRAPHY OF THE MIDDLE EOCENE JACAGUAS GROUP, PUERTO RICO: Micropaleontology, v. 7, no. 3, p. 351-358, 3 figs., chart, 2 pls., July 1961, 12 refs.

A survey is presented of the micropaleontology and biostratigraphy of the middle Eocene Jacaguas group. The Jacaguas group contains an early middle Eocene planktonic assemblage correlating with Bolli's *Hantkenina aragonensis* and *Globigerapsis kugleri* assemblage zones of Trinidad.--Auth.

3-2952. Wetzel, Otto. NEW MICROFOSSILS FROM BALTIC CRETACEOUS FLINTSTONES: Micropaleontology, v. 7, no. 3, p. 337-350, 3 pls., July 1961, 40 refs.

Some doubtful foraminiferal "brown bodies" in Bryozoa, "egglike" microfossils, dinoflagellates, hystrichospherids, Radiolaria, echinoderm sclerites, strobiliferid assemblages, and miscellaneous Problematika in Baltic Cretaceous flintstones are described, with taxonomic comments.--Auth.

3-2953. Said, Rushdi, and Moustafa T. Kerdany. THE GEOLOGY AND MICROPALAEONTOLOGY OF THE FARAFRA OASIS, EGYPT: Micropaleontology, v. 7, no. 3, p. 317-336, 13 figs., chart, 2 pls., table, July 1961, 27 refs.

The results of a micropaleontological study of material collected from Ain Maqfi, Farafra Oasis, are presented. Although this area was treated previously by LeRoy, this paper records in detail the planktonic Foraminifera of the section, as well as the reefal as-

semblages that are intercalated in and cap the Esna shale of this oasis. The planktonic forms have been given only moderate consideration by previous workers. The age of the Esna shale of Farafra is established as upper Paleocene; many of the primitive *Nummulites* and *Alveolina* species that occur in this succession are thus shown to be of upper Paleocene age. This work demonstrates by paleontological methods the presence of an unconformity between the Maestrichtian and the upper Paleocene, thus resolving an 80-year-long controversy.--Auth.

3-2954. Cousminer, Harold L. **PALYNOLOGY, PALEOFLORAS AND PALEOENVIRONMENTS:** *Micropaleontology*, v. 7, no. 3, p. 365-368, 5 figs., July 1961, 10 refs.

Changes in diversity of fossil polypore assemblages, traced through sedimentary series, are interpreted as having evolutionary and environmental significance in terms of the floras that produced them. Congruent corresponding changes in the frequency of first and last appearances lend support to these hypotheses. Paleobotanical remains and the physical history of the region, as deciphered directly from the sediments, are other sources of supporting evidence. Data from 3 comprehensive publications dealing with the description and stratigraphic distribution of fossil polypores are analyzed by this approach.--Auth.

3-2955. Wilson, L.R. **PALYNOLOGY AS A TOOL FOR ECONOMIC GEOLOGY:** *Micropaleontology*, v. 7, no. 3, p. 372-374, July 1961.

The economic value of palynology is an accepted fact but its practice is misunderstood by some oil companies. As in other disciplines, palynology has its limitations. These stem from the unsuitability of the method in certain rocks, a lack of knowledge on the part of the palynologists often hired by managements, the inferior equipment in use, and the absence of literature available. Those companies who understand these problems are successfully resolving many pertinent questions. Suggestions are made that will advance the value of palynology to science and industry.--Auth.

3-2956. Traverse, Alfred, and others. **POLLEN IN DRILLING-MUD "THINNERS," A SOURCE OF PALYNOLOGICAL CONTAMINATION:** *Micropaleontology*, v. 7, no. 3, p. 375-377, fig., table, July 1961, 2 refs.

Humic acid drilling-mud "thinners" derived from oxidized coal have been found to contain from 600,000 to 4,000,000 pollen and spores per gram of coal. Various brands of quebracho thinners contain, in addition to the primary constituent, quebracho extract, varying amounts of oxidized coal as a filler. Hence, such quebracho thinners are also a source of coal-derived pollen and spores. Palynologists, working with cuttings from which the drilling mud cannot be completely eliminated, must reckon with the built-in flora of the mud thinners.--Auth.

3-2957. Guennel, G.K., and Richard C. Neavel. **TORISPORE SECURIS BALME: SPORE OR SPO-**

RANGIAL WALL CELL?: *Micropaleontology*, v. 7, no. 2, p. 207-212, 2 figs., 3 pls., Apr. 1961, 8 refs.

The Indiana paper coal contains plant microfossils identifiable as *Bicoloria* Horst and *Torispora* Balme. The sporangium *Bicoloria* consists of an outer layer of *Torispora* and an interior mass of membranous spores. The sporangia, when found in clusters, are attached to each other at their pointed ends and are therefore thought to have been pendant. The name *Bicoloria* is restricted to intact sporangia, and the name *Torispora* is retained for isolated, dispersed spores. The range of *Torispora securis* is extended downward to include the upper Pottsville strata of Indiana (Westphalian B).--Auth.

3-2958. Funkhouser, John W. **POLLEN OF THE GENUS AQUILAPOLLENITES:** *Micropaleontology*, v. 7, no. 2, p. 193-198, fig., 2 pls., Apr. 1961, 4 refs.

The morphology, possible relationships, and distribution of fossil pollen of the genus *Aquilapollenites* are discussed, and the original generic description is emended. Seven new species are described.--Auth.

3-2959. Tozer, E. T. **THE SEQUENCE OF MARINE TRIASSIC FAUNAS IN WESTERN CANADA:** Canada, Geol. Survey, Paper 61-6, 20p., chart, table, 1961, 43 refs.

Two distinct faunal facies occur in the Triassic of western Canada: 1) where the fossils are cephalopods and thin-shelled pelecypods, tentatively called "pelagic facies"; 2) a benthonic facies of pelecypods and brachiopods found mainly in calcareous quartzose sandstone with some limestone. The first faunal facies is well developed in the Toad, "Dark siltstones," and Pardonet formations. The second facies is typically represented by the Liard formation and the "Grey beds." Benthonic faunas are widely distributed in the western Cordillera and contain corals, sponges, echinoderms, pelecypods, and brachiopods. Benthonic pelecypods include trigonids, ostreids, limids, pernids, pectinids, etc. Composition, distribution, and correlation of the pelagic faunas is discussed in some detail. Sequence of the Triassic faunas is shown in tabular form, and a table indicates their distribution and correlation in western Canada.--M. Stewart.

3-2960. Boucot, Arthur J., and others. **A LATE SILURIAN FAUNA FROM THE SUTHERLAND RIVER FORMATION, DEVON ISLAND, CANADIAN ARCTIC ARCHIPELAGO:** Canada, Geol. Survey, Bull. 65, 51 p., 10 figs., 10 pls., 1960, 59 refs.

A silicified fauna from the Sutherland River formation, Devon Island, Canadian Arctic Archipelago, found in the course of a helicopter survey by the Geological Survey of Canada, is of considerable interest because 1) its age places it near the Siluro-Devonian boundary and 2) it comes from the large Arctic region where paleontologic data are still meager. The fauna includes brachiopods, ostracods, conodonts, scolecondonts, trilobites, gastropods, and a fish plate, descriptions of which are provided. The age of the fauna is concluded to be Ludlovian, possibly upper Ludlovian.--Auth.

6. GEOPHYSICS

See also: Geologic Maps 3-2859 through 3-2874; Structural Geology 3-2911; Geohydrology 3-3086; Engineering Geology 3-3156.

3-2961. Hall, Thomas O. IS THERE A FUTURE NEED FOR GEOPHYSICS?: *Geophysics*, v. 26, no. 2, p. 133-137, Apr. 1961.

It has been estimated that the United States will need 14.2 million barrels of oil daily by 1970, necessitating the finding of 52 billion barrels of additional reserves in this country by that date, if a safe domestic reserve position is to be maintained. Present world oil surplus may not last more than 2 or 3 years. The exploration industry must turn to areas not intensely prospected outside the Middle East to develop future huge reserves. The industry must find 300 trillion cu. ft. of new gas by 1970. In the United States and in foreign countries a large portion of the needed new reserves of oil and gas must come from areas which are difficult to prospect, in which the use of geophysics is almost mandatory.

Under present market conditions, geophysical costs for finding oil in the United States are too high. Four avenues are open to the geophysical operator who intends to produce, at competitive prices, the future reserves needed by the United States and the free world: 1) reduce operating costs; 2) continuously develop effective new tools and techniques; 3) radically improve interpretative methods by making better use of the geophysical data obtained by field parties; 4) research.

Top-flight men are needed for development - all the experienced men now employed as well as new talent. At present only 566 students in all categories are studying geophysics in the United States, and fewer graduates are going on for advanced study. Many geophysics majors graduating with advanced degrees are not entering the field of exploration geophysics. This trend must be reversed by pointing out the future for geophysics and geophysicists and by encouragement from management.--A. C. Sangree.

3-2962. Beck, Alan E. ENERGY REQUIREMENTS OF AN EXPANDING EARTH: *Jour. Geophys. Research*, v. 66, no. 5, p. 1485-1490, 3 figs., May 1961, 16 refs.

To estimate the energy required for, and hence the physical possibility of, an expanding earth, the gravitational potential energy of the present earth and of various primitive earth models are compared. If the primitive density distribution is given by $\rho_r = \rho_0(1 - kr^n)$, then with plausible values of ρ_0 , k , and n , expansions of the radius of about 100 km., with a net loss of gravitational potential energy, cannot be ruled out. Earth models with moments of inertia higher or lower than that of the present earth can be selected from the range of plausible smaller primitive models available for each value of n . Expansions of the radius of about 1,000 km. can be entertained only if highly improbable density distributions are assumed. The conclusions are not substantially altered even when additional sources of energy are taken into account.--Auth.

3-2963. Zharkov, V. N. PHYSICS OF THE EARTH'S CORE II: MECHANICAL PROPERTIES AND VISCOSITY: *Akad. Nauk SSSR, Izvestiya, Geophysics Ser.*, in translation, 1960, no. 11, p. 1039-1044, 4 figs., pub. 1961, 10 refs.

The hypothesis of Gutenberg, according to which the wave dispersion in Bullen's F -layer is caused by

a viscosity gradient in that layer, is further analyzed. Two very simple models of the earth's core are investigated.--Auth.

3-2964. Hirvonen, R. A. THE REFORMATION OF GEODESY: *Jour. Geophys. Research*, v. 66, no. 5, p. 1471-1478, fig., May 1961, 9 refs.

Many theoretical discussions published by various geodesists during the last decades seem to have a common trend which means no less than the reformation of the very foundations of geodesy. There are 3 new ideas which have, in fact, no connection with each other except that they all can be expressed in a rather paradoxical form:

1) In gravimetric geodesy, the principal problem has been the determination of the geoid. According to the new theory, the geoid is quite unnecessary, and the determination of it is considered to be an unsolvable problem.

2) In geometric geodesy, most problems have been solved by the aid of geodetic lines on the surface of a reference ellipsoid. With modern technique of computation, this method is a detour which can be straightened by a 3-dimensional system of coordinates.

3) The theory of errors is often considered to be a special domain of geodesy. The theory of adjustments, however, should not be based on the vague concept of errors, but on modern mathematical statistics.

A brief summary of these 3 ideas is given.--Auth.

3-2965. Hill, David P., and Jimmy J. Jacobson. GRAVITY SURVEY IN THE WESTERN SNAKE RIVER PLAIN, IDAHO - A PROGRESS REPORT: *U. S. Geol. Survey, Repts., Open-File Ser.*, no. 609, 20 p., (in pocket), incl. map, profiles, 2 tables (in pocket), 1961, 6 refs.

From June 24 through Aug. 16, 1960, a regional gravity survey was made in 3,600 sq. mi. of the Snake River Plain in southwestern Idaho. Six hundred and seventy-two gravity stations were established between $42^{\circ}30'N$ - $43^{\circ}30'N$ and $114^{\circ}15'W$ - $116^{\circ}15'W$. At an average density of one station per 5.4 sq. mi. The data were reduced to simple-Bouguer gravity by standard methods and plotted as a gravity contour map.

Three major anomalies were defined by the survey: two 30-mi. long, en echelon gravity highs with amplitudes of 15 and 50 milligals, and one elongated gravity low with an amplitude of -10 milligals. A 2-dimensional graticule analysis suggests that the highs are caused by vertical slabs of dense rock (probably basalt), the largest about 4 mi. wide, about 30 mi. long, and extending from about 1,000 ft. (0.3 km.) below sea level to about 66,000 ft. (20 km.) below sea level. A possible geological interpretation is that the vertical slabs are large, en echelon, basalt-filled fissures or zones of fissures in the earth's crust. The gravity low is attributed to an alluvium-filled trough about 5,000 ft. (1.5 km.) deep.--Auth.

3-2966. Algermissen, S. T. UNDERGROUND AND SURFACE GRAVITY SURVEY, LEADWOOD, MISSOURI: *Geophysics*, v. 26, no. 2, p. 158-168, 6 figs., table, Apr. 1961, 11 refs.

A surface gravity survey consisting of 214 stations covering approximately 4 sq. mi. was conducted over and adjacent to the North Leadwood Mines at Leadwood, Missouri. A corresponding survey of 278 stations was carried out in the mine workings. A meth-

of reducing underground gravity observations is outlined. The principal factors limiting the accuracy of the underground observations are given. Methods for determining rock densities are described. A comparison of the surface and underground gravity maps shows that major Precambrian knobs were revealed by both surveys. Smaller structures not shown on the surface map were revealed by the underground survey. Anomalous density areas between the level of the 2 surveys were easily located.--Auth.

3-2967. Whitham, Kenneth. NATIONAL REPORT FOR CANADA. GEOMAGNETISM: Ottawa, Dominion Observatory, Pub. v. 24, no. 4, p. 87-98, 1960, 54 refs.

This report has been prepared on behalf of the sub-committee on Geomagnetism and Aeronomy of the Associate Committee on Geodesy and Geophysics, National Research Council of Canada. It has been compiled from material submitted by university departments and government institutions undertaking geomagnetic studies in Canada. Information on the extensive ground and airborne exploratory activities of commercial companies is not available to the compiler, and this account is limited to activities primarily of a noncommercial nature. Annual reports on geomagnetism and aeronomy have appeared in the Canadian Geophysical Bulletin published by the National Research Council.

The considerable expansion in geophysical activity in the Canadian Dept. of Mines and Technical Surveys and in Canadian universities during the period under review has resulted in a large increase in geomagnetic activity in Canada since the last national report (1957). The International Geophysical Year and International Geophysical Cooperation have accelerated this expansion.--From introd.

The report deals with the following fields: geomagnetic surveys; magnetic charts and maps; magnetic observatories and variation stations; developments in magnetic instruments; aeromagnetic interpretation and correlation studies; paleomagnetic and magnetic rock property studies; magneto-telluric and telluric current studies; research into the main geomagnetic field and its secular variation; studies of magnetic field variations; research into the E.M. method of prospecting.

3-2968. Chatterjee, J.S. MAGNETIC DISTURBANCES AND THE EARTH'S MAGNETIC FIELD: Jour. Geophys. Research, v. 66, no. 5, p. 1535-1546, 4 figs., May 1961, 15 refs.

An attempt is made to explain the origin of the observed magnetic field of the earth as being due to a current system circulating in the core, the current system in its turn being maintained by world-wide magnetic disturbances. The mantle behaves as a semiconductor, and the conduction electron density is given by the Boltzmann distribution law. The conductivity changes steeply along the radial direction, and a 'potential hill' is produced in the radial direction. Owing to interaction of the induced current with the steady magnetic field, a Hall potential is developed; this modifies the existing 'potential hill,' and hence the conductivity becomes to some extent dependent on the induced current vector. The consequent nonlinearity rectifies the induced current, and a net amount of unidirectional current aiding the existing magnetic field is left over at the end of the disturbance. This gradually penetrates down to the core and has a decay time of the order of a million

years. The net unidirectional current then grows through successive disturbances. It is shown that, for reasonable values of conductivity, temperature, and electron mobility, the magnetic disturbances maintain sufficiently large current in the core so that the earth's magnetism can be explained as entirely due to the magnetic disturbances.--Auth.

3-2969. Stacey, F.D., and John F. Lovering. THERMOMAGNETIC PROPERTIES, NATURAL MAGNETIC MOMENTS, AND MAGNETIC ANISOTROPIES OF SOME CHONDRITIC METEORITES: Jour. Geophys. Research, v. 66, no. 5, p. 1523-1534, 3 figs., 4 tables, May 1961, 29 refs.

Thermomagnetic analyses, thermal demagnetization of natural and laboratory-induced remanent magnetic moments, and measurements of magnetic anisotropy have been carried out on a number of chondritic stony meteorites. Eighty to 90% of the saturation magnetic moments were due to α -phase Fe-Ni (kamacite) containing 5 to 6% of Ni, and this phase was also responsible for most of the observed remanence and magnetic anisotropy. Minor magnetic constituents were determined with much less certainty. The natural magnetic moments of the Mt. Browne, Homestead, and Farmington chondrites had 2 components of quite different origins; in each case the important component appears to have been induced thermally in an extraterrestrial field. The Mokoia carbonaceous chondrite was found to have only a small moment, consistent with isothermal induction in the earth's field. The magnetic anisotropies of 8 chondrites were found to be related to the degree of metamorphism indicated by their porosities. The magnetic evidence is consistent with the supposition that the chondrites once formed parts of the mantle of a body with a fluid metal core which produced a magnetic field of terrestrial type.--Auth.

3-2970. Whitham, Kenneth, and E.R. Niblett. THE DIURNAL PROBLEM IN AEROMAGNETIC SURVEYING IN CANADA: Geophysics, v. 26, no. 2, p. 211-228, 15 figs., 4 tables, Apr. 1961, 8 refs.; also pub. as: Ottawa, Dominion Observatory, Contr., v. 5, no. 7, 1961.

Errors introduced into aeromagnetic survey results because of geomagnetic time variations have been analyzed in 2 ways. In the first, statistical properties of average magnetic disturbance have been calculated for 5 locations well distributed in latitude in Canada. The autocorrelation functions of vertical magnetic field fluctuations have been used to estimate errors in aeromagnetic surveying as a function of the length of the base loop and the length of the traverse lines or profiles, for 5 latitudes. In practical applications, the r.m.s. errors are proportional to the square root of elapsed time. These results can be explained in terms of the shape of the autocorrelation functions, and models of disturbance which might produce them are discussed.

In the second part experimental results are presented of a comparison of total field intensity fluctuations measured with recording proton precession magnetometers at 2 pairs of stations, one pair 26 mi. apart and the other 94 mi. apart. The measurements were taken in western Canada S. of the auroral zone. The r.m.s. differences in the time variations have been determined quantitatively for each hour for both pairs of stations; statistically, it was found that these differences were proportional to the r.m.s. level of magnetic activity and, in this region, to the separa-

tion of the stations. The frequency distributions of the r.m.s. differences between the 2 pairs of stations for the month of Sept. 1959 have been determined.

A comparison of the indirect and direct methods of correction indicates that scientifically, in this region, there is little to choose between them in terms of accuracy. Operational considerations are mentioned.--Auth.

3-2971. Ostenso, Ned A., and Charles R. Bentley. OBSERVED MAGNETIC DECLINATIONS IN WEST ANTARCTICA: Jour. Geophys. Research, v. 66, no. 4, p.1301-1302, Apr. 1961.

Declination observations were made at intervals of about 30-36 nautical ml. on 6 oversnow traverses and at each of the 7 stations occupied by an airborne traverse in W. Antarctica. The locations of all the observation sites are plotted on a map, along with isogonic lines contoured from these data at 100 intervals and isogonic lines plotted on H.O. Map 1706S (1960). Agreement between observed and computed declination is remarkably good. Such discrepancy as does exist may be due either to the fact that the observations were made over a period of 3 yr., during which some secular variation would occur, and (or) to the fact that magnetic susceptibility is higher than normal in the western part of W. Antarctica.--D.B. Vitaliano.

3-2972. Roy, Amalendu, and S. Jain. A SIMPLE INTEGRAL TRANSFORM AND ITS APPLICATIONS TO SOME PROBLEMS IN GEOPHYSICAL INTERPRETATION: Geophysics, v. 26, no. 2, p. 229-241, 7 figs., Apr. 1961, 10 refs.

A simple integral transform, defined by

$$f(x) = \int_{-\infty}^{+\infty} F(x, y) dy,$$

where $F(x, y)$ represents the measured geophysical field and x and y are suitably chosen directions, has been used for formulating convenient interpretation techniques to some geophysical problems that are normally not amenable to easy quantitative interpretation. Some synthetic numerical examples are given.--Auth.

3-2973. Henkel, John H., and T.C. Collins. INDUCED POLARIZATION IN ELECTROLYTE SATURATED EARTH PLUGS: Geophysics, v. 26, no. 2, p. 205-210, 6 figs., Apr. 1961, 6 refs.

This paper describes the results of some studies of the dependence of induced polarization and of the formation resistivity factor upon solution concentration in saturated porous plugs. Two theories based upon 2 different simple models are developed. The first treats induced polarization as an electric dipole polarization occurring at the surface of clay particles. It is a relaxation theory that does not lead to results agreeable with experiments. The second theory treats induced polarization as a concentration polarization which is induced at solution-clay surfaces when current flows across the surfaces. The second theory is more successful than the first in 2 ways: 1) it leads to a time dependence more consistent with the experimental decays; 2) it leads to equations involving the resistivity of the saturating solution ρ_s which are also more consistent with experiments.--Auth.

3-2974. Duesterhoeft, W. Charles, Jr. PROPAGATION EFFECTS IN INDUCTION LOGGING: Geo-

physics, v. 26, no. 2, p.192-204, 11 figs., Apr. 1961, 9 refs.

Induction logging utilizes the component of induced receiver coil voltage that is in phase with transmitted coil current as a measure of the conductivity of material surrounding the coils. This paper considers the problem of the field of a vertical magnetic dipole in a horizontally stratified, isotropic conductive formation and shows the receiver coil voltage can be considered as composed of responses due to electromagnetic waves in the formation. These waves which experience attenuation and phase shift as they propagate into the formation are reflected at each interface encountered, and a component of receiver coil voltage is induced for each passage of a wave. The relation of the receiver coil voltage components to the geometric factor of previous analysis is discussed. Universal curves that are useful in determining the response due to unreflected primary and reflected secondary waves are presented. Example induction log system responses based on the analysis of the present paper are presented.--Auth.

3-2975. Vladimirov, N. P., and M. V. Kolmakov. THE RESOLVING POWER OF THE MAGNETO-TELLURIC METHOD: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 11, p.1066-1068, 4 figs., pub. 1961, 2 refs.

Theoretical studies made for a geo-electrical section of type $\rho_1 < \rho_2 < \rho_3 = \infty$ indicate that the magnetotelluric method, in comparison with the method of resistances to a direct current, has a greater resolving power in the development and following of layers of adequate thickness. However, because of the applicability of the principle of equivalence this method likewise cannot independently solve the problem of separating in a section layers of a low degree of thickness.--Auth. concl.

3-2976. Schaub, Yu. B. THE DIRECTED RECEPTION OF SECONDARY SIGNALS IN ELECTRO-PROSPECTING BY THE METHOD OF A ROTATING MAGNETIC FIELD: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 11, p.1074-1076, 2 figs., pub. 1961, 3 refs.

A diagram for the method of a rotating magnetic field is examined. It follows from the diagram that this method of electro-prospecting has special features which enable us to effect directed reception and to directly determine the direction in local, readily conducting ore bodies.--From auth., p. 1074.

3-2977. Willmore, P. L. THE NEW SEISMOGRAPH STATION AT RESOLUTE, NORTHWEST TERRITORIES: Ottawa, Dominion Observatory, Pub. v. 24, no. 5, p.101-111, 16 figs. incl. illus., diags., graphs, 1960, 3 refs.

In 1957, the Dominion Observatory seismograph station at Resolute, N.W.T., was replaced by a larger station with modern instrumentation. The new station contains 3 seismographs of short period, 3 of intermediate period and 3 of long period. The construction of the station and the procedure for setting up the instruments are described. Calibration curves from all the instruments are included.--Auth.

3-2978. Sengbush, R. L., and others. INTERPRETATION OF SYNTHETIC SEISMOGRAMS: Geophysics, v. 26, no. 2, p.138-157, 22 figs., Apr. 1961, 15 refs.

A linear filter model of the complicated seismic process can be formulated by assuming that 1) the layering of the earth is described by the continuous velocity log, 2) the shot pulse is time-invariant and propagates as a plane wave with normal incidence, and 3) all multiples, ghosts, and other noise are negligible. Then, the model earth with discrete layers can be considered a filter whose impulse response is the set of reflection coefficients. The set of reflection coefficients becomes the reflectivity function when the model earth has a continuously varying velocity. By definition, the reflectivity function is the derivative of the logarithm of velocity, where both are functions of 2-way travel time. The input to this filter is the time-invariant shot pulse. The output is a synthetic seismogram that contains the reflectivity function filtered by the shot pulse; in other words, it consists of primary reflections only. Since the filter is linear, the input and the filter may be interchanged, the reflectivity function becoming the input and the shot pulse becoming the filter.

A nonmathematical discussion of the reflections from simple, ideal velocity layering shows that: 1) The reflection from a step velocity function is the shot pulse itself. 2) Thin beds produce a differentiated shot pulse. 3) Beds which approximate a square pulse in velocity produce a pair of shot pulses, with a second delayed in time and reversed in phase with respect to the first. The composite reflection has its greatest amplitude when the layer thickness (in 2-way travel time) is one-half the basic period of the shot pulse. This situation is called "tuning." The strongest reflections on field records result when the shot pulse is tuned to the velocity layering. 4) Ramp-transition zones (linear increase in the logarithm of velocity) produced integrated shot pulses at the changes in slope of the velocity function.

A correspondence can be established between the velocity function and the synthetic seismogram by shifting the velocity function later in time. The shift is required because of "filter delay." The amount of filter delay is related to the impulse response waveform, which, in the case of the synthetic seismogram, is given by the reflection from a step velocity function.--Auth.

3-2979. Caputo, Michele. DEFORMATION OF A LAYERED EARTH BY AN AXIALLY SYMMETRIC SURFACE MASS DISTRIBUTION: Jour. Geophys. Research, v. 66, no. 5, p. 1479-1483, May 1961, 5 refs.

Series expressions are developed for the surface displacements of a spherical earth model, deformed by both surface tractions and body forces arising from an axially symmetric distribution of mass over its surface. The model consists of $m-1$ homogeneous elastic spherical shells, plus an inner core which is treated either as elastic or as a liquid.--Auth.

3-2980. Holzmann, F.M. ON THE EXPERIMENTAL ANALYSIS OF INTERFERENCES AND OF THE RELIABILITY OF THE RESULTS OF THE GROUPING OF SIGNALS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 12, p. 1140-1146, 5 figs., pub. 1961, 4 refs.

The author investigates the fundamental characteristics of x - and t -expressions of a signal and of an interference. Some methods of the experimental analysis of these properties are examined. It is demonstrated that the results of the grouping of signals appear to be reliable only on the condition that

the spectra of the x -expressions of an effective signal and of the interference are separated. Some qualitative criteria of reliability evaluation are suggested.--Auth.

3-2981. Holzmann, F.M. STATISTICAL EVALUATION OF THE RELIABILITY OF THE RESULTS OF THE GROUPING OF SIGNALS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 12, p. 1147-1153, 4 figs., 2 tables, pub. 1961, 5 refs.

The author suggests a probability evaluation of the reliability of the axes of cophasality obtained in the grouping of signals. Some practical methods for the calculation of the reliability are examined. The dependence of the reliability of the axes isolated on the conditions of the experiment is investigated.--Auth.

3-2982. [Timoshin, Yu. V.] ON THE THEORY OF GROUPING: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 12, p. 1154-1160, 4 figs., pub. 1961, 10 refs.

The theory of grouping is discussed for impulse oscillations based on the Laplace transform. Simple analytic expressions for impulse characteristics of directivity for various forms of grouping and impulses of different shapes are obtained.

A method of selecting parameters of grouping is given which takes into account the impulse character of seismic oscillations and the ratio of amplitudes of the useful waves to the interference before and after grouping.

It is shown that in the region of the fundamental maximum the impulse characteristics of directivity are very similar to characteristics for harmonic oscillations. In the region of suppression, impulse characteristics have no zeros and do not have clearly expressed secondary maxima (for impulses consisting of 2-3 oscillations).

It is shown that the effectivity (coefficient of suppression) of nonuniform distributions decreases with an increase of the rate of attenuation of the impulses, as a result of which, in fixed conditions, uniform groups are most effective.

A method of experimental construction of impulse characteristics of directivity is presented which uses the apparatus of RNP.--Auth. concl.

3-2983. Belotelov, V.L., and others. DETERMINATION OF THE ENERGY OF THE EARTHQUAKE OF 11/15/59: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 11, p. 1062-1065, fig., pub. 1961, 8 refs.

The energy of body and surface seismic waves from the earthquake in Greece (38°N , and 20.3°E .) that occurred on Nov. 15, 1959, at $17^{\text{h}}08^{\text{m}}40^{\text{s}}$ was calculated. The energy of the incident body waves ranged from 170 to 600 ergs per cm^2 for P-waves and from 190 to 670 ergs per cm^2 for S-waves; the total surface wave energy was 15,800 ergs per cm^2 . The magnitude was 6.8, and intensity 8-9 points. The energy at the focus $E_p + E_s$ was 3.2×10^{20} - 11.4×10^{20} ergs.--A. J. Schneiderov (courtesy Geophysical Abstracts 184-138).

3-2984. Belotelov, V.L., and N.V. Kondorskaya. ON THE QUESTION OF THE DETERMINATION OF THE ENERGY OF EARTHQUAKES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation,

1960, no. 12, p. 1164-1172, 5 figs., 4 tables, pub.
1961, 15 refs.

The results of the determination of the energy of longitudinal and transverse waves for 10 Far Eastern earthquakes are presented, using a method which had been suggested earlier by the authors. The results that were obtained agree with the energy values that had been calculated by means of the formula of Gutenberg and Richter which is based upon the determination of the magnitude M for the earthquakes in question.

An attempt is made to construct an "energy hodo-graph"; there is a general tendency for the increase of $\lg E$ with epicentral distance for P and S waves which is estimated.--Auth.

3-2985. Tabulevich, V. N. THE MAKHACHKALA EARTHQUAKE OF MARCH, 1960: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 11, p. 1077-1078, illus., map, table, pub. 1961, ref.

The earthquake occurred during the night of March 20/21, 1960, in this Caspian Sea region. The epicenter was located at 42°45'N. 47°40'E., and the shocks had magnitudes of $M = 4.5$ and 4.2 . The focal depth was approximately 8 km. Building damage in the epicentral zone 20-25 km. SE. of Makhachkala and at Makhachkala is described briefly.--A. C. Sangree.

3-2986. Bulin, N. K., and E. I. Tryufilkina. UTILIZATION OF CONVERTED SP WAVES OF LOCAL EARTHQUAKES IN STUDYING THE STRUCTURE OF THE DEEPER CRUST: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 11, p. 1050-1055, 8 figs., 2 tables, pub. 1961, 11 refs.

Converted SP waves recorded during local earthquakes can be utilized in studying the structure of the deeper crust.

The converted SP wave method can be applied efficiently in conjunction with other investigations - the converted PS wave method and GSZ. Also possible is the independent application of seismological investigations which utilize converted SP waves insofar as such investigations ensure sufficiently detailed information, primarily on the higher portions of the crustal profile.

Application of this method is recommended in areas located not over 1,000 to 1,500 km. from the epicenter of the earthquake.--Auth. concl.

3-2987. Khorosheva, V. V. SOME RESULTS OF THE INVESTIGATION OF P_a AND S_a WAVES FROM THE SEISMOGRAMS OF STATIONS OF THE USSR: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 11, p. 1045-1049, 5 figs., pub. 1961, 21 refs.

As against some foreign authors, who observed the P_a and S_a waves only from foci located within the waveguide, such waves have been discovered during earthquakes having foci within the limits from 50 to 640 km.

The obtained travel-time curves of the P_a and S_a waves are rectilinear, and the velocities of the waves are, respectively, 8.30 (+0.03) and 4.57 (+0.03) km./sec.

For a P_a wave the value of the index of the geometric divergence is close to 1/2; the absorption coefficient is on an average equal to 0.000144 km.⁻¹.

The rectilinearity of the travel-time curves of the

waves, their velocities, and the propagation distance, confirm the presence in the upper layers of the earth's mantle of a waveguide layer.--Auth. concl.

3-2988. Pasechnik, I. P. DETERMINATION OF THE PARAMETERS OF ATTENUATION OF THE WAVES P_n AND S^* : Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 12, p. 1161-1163, fig., pub. 1961, 7 refs.

The exponent "n" of the divergence function and the amplitude coefficient of absorption "a" are evaluated from amplitude curves of the waves P_n and S^* , obtained on a longitudinal profile during underground nuclear explosions of 5 and 19 kilotons, and also in the Arys' TNT explosion, by 2 independent methods. For the P_n waves, which have periods of oscillation from 0.6 to 0.8 sec., the average values are $n \approx 2.0$, $a = 0.0022$ km.⁻¹; for the S^* waves, which have periods of 1.0-1.2 sec., $n \approx 1.7$, $a = 0.0023$ km.⁻¹.--Auth.

3-2989. Phinney, Robert A. LEAKING MODES IN THE CRUSTAL WAVEGUIDE. PART 1. THE OCEANIC PL WAVE: Jour. Geophys. Research, v. 66, no. 5, p. 1445-1469, 25 figs., 2 tables, May 1961, 7 refs.

The problem of the seismic signal associated with the earliest P wave is treated by application of normal mode theory, in which the signal is regarded as a quasi-surface wave, coupled both to the motion of the earth's layered surface and to body waves propagating in the underlying media. Predictions made for the particular model assumed are relevant to explosion and earthquake sources. The oscillations following the initial P motion are explained.

The transient solution obtained by Rosenbaum for leaking mode propagation in an acoustic waveguide has been generalized to describe propagation in an elastic halfspace overlain by a liquid layer. The early-arriving PL modes known from earthquake studies have been computed for several theoretical models to test the effect of the elastic constants on their dispersion and attenuation. Physical reasoning, based on harmonic plane wave models, appears inadequate for predicting many features of the exact dispersion and attenuation. The analogy between PL waves and normal modes in the case treated by Pekeris is exploited, and it is also believed that PL waves are related to an attenuated pseudo-surface wave of a free solid halfspace. Late-arriving quasi-standing waves are treated briefly, and their relevance to certain seismic phenomena is mentioned.--Auth.

3-2990. Riznichenko, Yu. V., and O. G. Shamina. MULTIPLE REFLECTED AND TRANSMITTED WAVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 12, p. 1129-1139, 14 figs., pub. 1961, 8 refs.

A theoretical discussion of a problem on dispersed summarized multiple waves, reflected and transmitted refracted seismic waves in a multi-layered medium with thin dispersion layers. Experiments are described on ultrasonic pulse modeling of reflection and transmission of seismic waves in a medium having thin layers. A comparison of the experimental results with theoretical computations are discussed.--Auth.

3-2991. Geertsma, J., and D. C. Smit. SOME ASPECTS OF ELASTIC WAVE PROPAGATION IN

FLUID-SATURATED POROUS SOLIDS: Geophysics, v. 26, no. 2, p. 169-181, Apr. 1961.

Biot's equations for the propagation of dilatational waves in fluid-saturated porous solids in the low-frequency range are analyzed for the purpose of application in geophysical research. The deformation constants of the system are unraveled in terms of compressibilities and porosity, and suitable approximate solutions for wave velocity and attenuation of the waves of both the first and second kind are obtained. A saturated elastic porous solid is found to behave, as far as the wave of the first kind is concerned, approximately as a standard element. The wave of the second kind rapidly dies out with increasing distance from the source, and consequently one might infer that in seismic studies only the wave of the first kind needs consideration. It is shown, however, that its presence has an effect upon the reflection and absorption at any interface between 2 different fluid-saturated porous solids. At such an interface a wave of the second kind is again generated. General formulae for the reflection and absorption for normal incidence at the interface are obtained, which include the effect of second-wave generation.

Additional results of the investigation are the following: A rather simple formula for the speed of sound in sedimentary rocks (the wave of the first kind) is obtained, which has to replace the so-called "time-average relation" now sometimes used. A comparison between the results obtained here and published results on wave propagation in simpler fluid-solid systems, such as, for instance, suspensions, showed some weak points in the older theories. Suggestions for possible improvements are given.--Auth.

3-2992. California, University, Radiation Laboratory, Livermore. PROBING THE EARTH WITH NUCLEAR EXPLOSIONS. By David T. Griggs and Frank Press: U.S. Atomic Energy Comm., [Pub.] UCRL-6013, 40 p., 6 figs., table, 1960, 20 refs.

Progress in seismology is reviewed with emphasis on the usefulness of past nuclear weapon tests in determining the internal structure of the earth. The advantages of using large chemical explosions and future nuclear explosions detonated under the Plowshare program as controlled energy sources for carefully instrumented seismological experiments are discussed. Finally, an international program of explosions for seismological research is proposed, and specific suggestions are made for attacking several outstanding problems in seismology by means of chemical and clean nuclear explosions and the instrumentation network proposed at Geneva for nuclear test detection.--Auth. summ.

3-2993. California, University, Radiation Laboratory, Livermore. APPLICATION OF NUCLEAR EXPLOSIONS AS SEISMIC SOURCES. By Gerald W. Johnson: U.S. Atomic Energy Comm., [Pub.] UCRL-6030-T, 51 p., 8 figs., 5 tables, 1960, 27 refs.

The nuclear experience and its interpretation is summarized, with a description of methods of stemming the explosion to assure containment of radioactivity. Included are estimated typical costs that might be incurred in the United States to provide seismic sources under various circumstances.

In a table are listed the underground nuclear explosions set off at the Nevada Test Site, dates and times of firing, and the coordinates of the centers of

detonation. All of the explosions took place in the same geographical area at the Nevada Test Site in the western United States and all took place in the same medium - a type of tuff. The relative locations of the several detonations are shown in a vertical section of the mountain. The depth of placement, the energy release, and other data concerning the explosions are listed. The general average properties of the medium are given.--From auth., p. 9, 11.

3-2994. Rykunov, L. N., and others. A TWO-DIMENSIONAL MODEL OF A SEISMIC WAVEGUIDE WITH SOFT BOUNDARIES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 11, p. 1069-1071, 6 figs., pub. 1961, 4 refs.

The ability of some materials to alter their elastic properties with a change in the temperature makes possible the building of solid models of stratified media with eroded and abrupt boundaries, as well as media having smoothly-changing velocities.

A paraffin-polyethylene compound investigated as an example for the building of the model of a waveguide having diffuse boundaries possesses satisfactory properties with temperatures up to +20°. Within the range of temperatures from 10 to 20°, the paraffin-polyethylene compound, with fairly constant values of absorption, density and Poisson's ratio, produces a drop in the velocities of the P and S waves of 16 to 18%.--Auth. concl.

3-2995. Bayuk, E. I. THE INVESTIGATION OF THE ELASTIC PROPERTIES OF ROCK SAMPLES TAKEN FROM A DEEP BOREHOLE AT HIGH PRESSURES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 12, p. 1173-1177, 2 figs., 2 tables, pub. 1961, 11 refs.

The elastic parameters were determined for rock samples from the Novo-Alekseevskaya deep borehole at high all-around pressures with the application of methods whereby the velocities v_{PM} and v_{prod} of the longitudinal waves are measured on a single sample.

The experiments demonstrated that the elastic parameters of rocks increase with an increase in pressure especially intensively up to 1,000 kg./cm.², and that they also depend on the depth from which the samples were taken, as well as on the mineralogical composition of the rock.

A comparison was carried out of the laboratory values of the velocities of longitudinal waves measured with the pressure taken into consideration, to the data of the seismic logging of the Novo-Alekseevskaya borehole. A good agreement was in this case obtained between the v_{PM} velocities and the layer velocities.--Auth. concl.

3-2996. Konstantinova, A. G. TIME DISTRIBUTION OF ELASTIC PULSE ENERGY DURING DESTRUCTION OF ROCKS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 11, p. 1056-1061, 4 figs., pub. 1961, 8 refs.

Analysis of the time distribution of elastic pulse energy reveals certain aspects of the fracturing process during destruction of rock specimens under mono-axial compression, and in coal seams during periods of preceding sudden discharges of coal and gas.--Auth.

3-2997. Scott, James H., and others. QUANTITATIVE INTERPRETATION OF GAMMA-RAY LOGS:

Geophysics, v. 26, no. 2, p. 182-191, 11 figs., Apr. 1961, 4 refs.

A quantitative method for determining the concentration of gamma-ray emitting elements in layered rocks penetrated by boreholes has been developed by the U. S. Atomic Energy Commission. It is based on the relationship

$$\bar{G}T = k \int_{-\infty}^{+\infty} I dz$$

where \bar{G} is the mean thickness T , k is a constant of proportionality, and I is the intensity of the gamma-ray field along the borehole axis at a distance z from a fixed point of reference on the axis. This relationship has been confirmed theoretically and empirically.

In application, the grade-thickness product of a mineralized zone intersected in the borehole is determined by multiplying the area under the gamma-ray log curve by a constant of proportionality. The mean grade of the zone is determined by dividing the grade-thickness product by the zone thickness. Corrections applied for nonstandard conditions in the borehole reduce the data to equivalence with standard calibration conditions. Because the volume sampled in this logging method is significantly larger than that of core samples, the resulting data are more representative than data from chemically-assayed core.--Auth.

3-2998. Cheremensky, G. A. TIME OF REESTABLISHING THE THERMAL CONDITIONS DISTURBED BY DRILLING A BOREHOLE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1960, no. 122 p. 1205-1208, 2 figs., 2 tables, pub. 1961, 8 refs.

In determining the time of reestablishment of the thermal conditions disturbed by drilling it is necessary to consider the effect of the zone of disturbance of the constant thermal state of the rocks. The diameter of the zone of disturbance depends upon the time and intensity of the washing of the borehole by the drilling solution, its temperature and the temperature of the rocks before drilling, and on the geological and hydrogeological features of the region.

The time of reestablishing the thermal conditions must be selected in accordance with the existing errors in determining the temperature. The theoretical curves presented make it possible to evaluate the time necessary for reestablishing the thermal state of rocks disturbed by drilling.

In order to secure more reliable data on the temperatures in the upper part of the earth's crust it is necessary to make highly exact thermal studies even in some basic boreholes after they have been at rest for a suitably long time. Study of the cooling or heating of the drilling solution in the borehole makes it possible to study the thermal properties of rocks under their natural conditions of occurrence.--Auth. concl.

7. GEOCHEMISTRY

See also: Stratigraphy 3-2923; Mineralogy 3-3072; Geohydrology 3-3089, 3-3090, 3-3096; Mineral Deposits 3-3106, 3-3109, 3-3112, 3-3113, 3-3114, 3-3120, 3-3125; Fuels 3-3138.

3-2999. Ronov, A. B. ON THE POST-PRECAMBRIAN GEOCHEMICAL HISTORY OF THE ATMOSPHERE AND HYDROSPHERE: Geokhimiya, in translation, 1959, no. 5, p. 493-506, 4 figs., table, pub. 1960, 46 refs.

The examined data show that in the system atmosphere-ocean, in the post-Precambrian geological periods the mechanism of removal and fixation of the abyssal (volcanic) carbon dioxide by the precipitation of the carbonates and by the photosynthetic fixation of carbon by green plants was continuously active. When viewed over considerable intervals of time equal in length to geological epochs, this mechanism appears to have been quite accurate. The quantity of the carbonate sediments deposited in this or that epoch was directly proportional to the intensity of volcanism and to the area covered by inland seas. Against the background of dynamic equilibrium between the addition and fixation of CO_2 in post-Precambrian time, the average partial pressure of carbon dioxide in the system atmosphere-ocean diminished. During the Paleozoic the decrease in PCO_2 was very slow but it accelerated sharply beginning with the Mesozoic. An indicator of this process is the change in the Ca/Mg ratio in the carbonate rocks with time.--Auth. summ.

3-3000. Carr, Michael H., and Karl K. Turekian. THE GEOCHEMISTRY OF COBALT: Geochim. et Cosmochim. Acta, v. 23, no. 1/2, p. 9-60, 16 figs., 25 tables, Apr. 1961, 106 refs.

Co has been determined in a wide variety of geologically interesting materials using the combined techniques of emission spectrography and neutron ac-

tivation analysis. Neutron activation was used to analyze standards for the emission spectrograph and materials low in Co. The following table is a summary of the results obtained with these methods.

	Co (p.p.m)	Co/Fe ($\times 10^4$)	Co/Mg ($\times 10^4$)
Basaltic rocks	48	6.0	12
Granodiorites	7	2.5	7.0
Granites	1	0.6	6.4
Schists	40	5.3	9.3
Shales	19	4.9	14
"Pure" limestone	0.1	-	-
Quartzite	0.3	-	-

During differentiation of a basaltic magma (as in the case of the Stillwater complex) most of the Co enters the ferromagnesian minerals. The Co content of these minerals depends on the total number of Fe-Mg lattice sites and is independent of the Fe/Mg ratio. This relationship appears to hold for basaltic rocks in general. Co is strongly coherent with Mg in granitic rocks and behaves like Mg in its partition relations between metamorphic minerals. The acceptance of both Co and Mg is more selective at lower grades of metamorphism. These observed coherence relations require a reevaluation of the geochemical laws governing the distribution of trace elements in the petrogenesis of igneous and metamorphic rocks and the partition of trace elements between coexisting minerals.

In sediments most of the Co is in the argillaceous fraction and seems to follow Fe and Mn. The Co economy in the deep sea is discussed, and we conclude that with present knowledge, the Co accumulations in deep-sea sediments may be explained as the result of supply of detritally associated Co and dissolved Co from surface runoff rather than volcanic exhalations.

The crustal abundance of Co is calculated as 27 p.p.m on the model of a crust of basalt and granodiorite in equal proportions.--Auth.

3-3001. Pistorius, Carl W. F. T. A NOTE ON SO-CALLED "PRESSURE INDEPENDENT" MINERALS: *Am. Mineralogist*, v. 45, no. 9/10, p. 1097-1098, Sept.-Oct. 1960, 4 refs.

The term "pressure independent" should not be used for a mineral merely because it has a thermodynamic stability range of 1 atm. The term implies that the stability field of such a mineral is actually independent of pressure, something which can only be the case when the phase boundary delineating the stability field of the mineral is in the P-T plane.--D. O. Emerson.

3-3002. Ames, L. L., Jr. ANION METASOMATIC REPLACEMENT REACTIONS: *Econ. Geology*, v. 56, no. 3, p. 521-532, 10 figs., table, May 1961, 8 refs.

Data on the kinetic anion replacement systems calcite- PO_4^{3-} , calcite- F^- , gypsum- CO_3^{2-} , and gypsum- PO_4^{3-} are given, along with concomitant Sr^{+2} inclusion into the final product. In a system containing several anions, only the anion forming the least soluble compound with the available cation is stable. The replacement reaction rate is directly proportional to the solubility difference between the original solid and final product. Several other variables also affect the reaction rate including temperature, column flow rate, influent pH, surface area of the initial solid, concentration of extraneous ions, and concentration of active anion. These variables affect diffusion rates to and from reaction sites as well as differences in solubility between initial and final reaction products. The crystal structure of the resulting product greatly affects the concomitant removal rate of Sr^{+2} into the resulting product.--Auth.

3-3003. Knapp, William John, and H. Flood. ACTIVITIES AND STRUCTURE OF SOME BOROSILICATE MELTS: *Geochim. et Cosmochim. Acta*, v. 23, no. 1/2, p. 61-77, 12 figs., 7 tables, Apr. 1961, 22 refs.

The application of structural models to some calcium borosilicate melts was made to develop simple expressions of activities as functions of composition. Their applicability was tested with freezing point depression data from phase diagrams. The activity values obtained were compared with those computed from the calorimetric heat of fusion. Data from published phase diagrams for the systems $\text{Ca}_2\text{B}_2\text{O}_5\text{-Ca}(\text{BO}_3)_2$, $\text{Ca}_3(\text{BO}_3)_2\text{-Ca}_2\text{SiO}_4$, $\text{Ca}(\text{BO}_3)_2\text{-CaSiO}_3$, and $\text{Ca}_2\text{B}_2\text{O}_5\text{-CaSiO}_3$ were used. Simple ionic models seemed applicable to melts where isolated ions may be expected; in melts containing mixed ions in chains and rings, the so-called "group" model may be useful.--Auth.

3-3004. Khitarov, N. I., and others. THE SOLUBILITY OF WATER IN BASALTIC AND GRANITIC MELTS: *Geokhimiya*, in translation, 1959, no. 5, p. 479-492, 9 figs., 3 tables, pub. 1960, 10 refs.

The solubility of water in the basaltic melt at 900°C. and the pressure of 3,000 kg./cm.² is about half of the solubility of water in the granitic melt under the same conditions. In the former, it is 3.2 - 3.6%, and in the latter, 6.8%.

At 1,000°C. and under the same pressure, the dif-

ference in the solubility of water in the 2 melts diminishes. The basaltic melt dissolves 5.38% of water and the granitic melt, 5.65%. This suggests the possibility that in a nearby high temperature region the 2 melts may dissolve the same amount of water in spite of the difference in their chemical composition.

The presence of hornblende in the quenched basaltic melts and the usual absence of it from the natural basalts and diabases may be regarded as an indication of low water content in the primary magma.

Basaltic magma rising from the depths where the temperature is 900°C. and pressure 3,000 kg./cm.² may be pictured as a very mobile melt with pyroxene and olivine crystals floating in it.--Auth. summ.

3-3005. Ikornikova, N. Yu. THE PROCESS OF SOLUTION OF CALCITE IN AQUEOUS SOLUTIONS OF CHLORIDES AT HIGH TEMPERATURES AND PRESSURES: *Kristallografiya*, in translation, v. 5, no. 5, p. 726-733, 10 figs., March-Apr. 1961, 8 refs.

The solution of calcite in water solutions of the chlorides NaCl, LiCl, CaCl_2 , NH_4Cl was studied at 350-500°C. and 100-1,800 atm. A single crystal of calcite was suspended in a stainless steel autoclave. The vessel was quenched in cold water after firing, and solubility was determined by weight loss of the single crystal. Solubility was determined in solutions containing either one or several salts at various temperatures and pressures.--E. G. Ehlers.

3-3006. National Academy of Sciences-National Research Council, Subcommittee on Nuclear Geophysics. PROBLEMS RELATED TO INTERPLANETARY MATTER. Proceedings of an Informal Conference, Highland Park, Illinois, June 20-22, 1960: *Natl. Acad. Sci.-Natl. Research Council*, Pub. 845 (*Nuclear Sci. Ser.*, Rept. no. 33), 105 p., figs., tables, 1961, refs.

The fourth conference sponsored by the Subcommittee on Nuclear Geophysics of the Committee on Nuclear Science. The proceedings of the meetings were recorded; then the written reports were circulated to the various speakers for review and emendation. The final report thus represents the speakers' final judgment of the content of the papers. Questions and responses have in many cases been modified and incorporated into the text for purposes of clarity and continuity. Papers presented at the conference are listed below.--L. M. Dane.

The Origin of the Solar System, by A. G. W. Cameron. Comments on the Time Dependence of Nucleosynthesis, by Truman P. Kohman.

Xenon in Stone Meteorites, by John H. Reynolds. Primordial Argon and Neon in Stone Meteorites, by Heinz Stauffer.

Cosmic Ray Ages of Iron Meteorites, by Oliver A. Schaeffer.

Argon-37, Argon-39 and Tritium in Recent Meteorite Falls, by E. L. Fireman.

The Distribution of Rare Gases in Iron Meteorites, by Peter Signer, and Alfred A. Nier.

Cosmic Ray Production of Radioactive Nuclides in Iron Meteorites, by J. R. Arnold.

Cosmogenic Nuclides in the Hamlet Meteorite, by Anthony Turkevich.

The High Energy Cosmic Ray Spectrum, by S. Olbert. Lower Energy Cosmic Rays and the Solar Cycle, by P. Meyer.

On the Geophysical and Geonuclear Significance of the Earth's Radiation Belts, by James A. Van Allen.

Micrometeorite Studies from Earth Satellites, by W.

M. Alexander.
Exploration of the Moon and Planets, by A.R. Hibbs.
Diamonds in Meteorites, by Edward Anders.
Heavy-Element Activation Analyses of Meteorites, by George W. Reed, Jr.
Strontium and Rubidium in Stone Meteorites, by Paul W. Gast.
Secular Changes in the Concentration of Atmospheric Radiocarbon, by Hans E. Suess.
Radium-Uranium Age Determinations on Marine Shells, by Wallace S. Broecker.
Oxygen Isotope Measurements in Glacial Ice, by S. Epstein.

3-3007. Fisher, David E. SPACE EROSION OF THE GRANT METEORITE: Jour. Geophys. Research, v. 66, no. 5, p. 1509-1511, table, May 1961, 11 refs.

An upper limit to the erosion of Fe meteorites in space is calculated, based on the cosmic exposure age of the Grant meteorite and the measured depth variation of cosmogenic Ne^{21} in this meteorite. A value for E_{max} of $\sim 1.1 \times 10^{-8}$ cm/yr. is found. A previous estimate based on the Sikhote-Alin meteorite is discussed.--Auth.

3-3008. Read, William F. THE SAXEVILLE METEORITE: Wisconsin Acad. Sci., Arts & Letters, Trans., v. 49, p. 191-198, 3 figs., 1960, 3 refs.

Standard catalogs of meteorites list an "Fe with silicate inclusions" from the vicinity of Saxeville in Waushara County, Wisconsin. Slices and fragments are preserved in various major collections, but no general description has hitherto been published. This study is based on 236 g. in the collection at Lawrence College. A brief history of the meteorite is given, followed by observations on its composition and structure. The metallic portion consists mainly of granular-octahedral Ni-Fe, with scattered blebs of schreibersite and troilite. Stony portions show a crystalline mosaic structure and consist of about 46% pyroxene, 32% olivine, 0.5% plagioclase, and 21.5% Ni-Fe and troilite. No chondrules have been observed. The metal seems to be in the form of a vein, or veins, intruded along fractures in the stony material and to a limited extent replacing it.--Auth.

3-3009. Sarma, D. V. N., and Toshiko Mayeda. METEORITE ANALYSIS: THE SEARCH FOR DIAMOND: Geochim. et Cosmochim. Acta, v. 22, no. 2-4, p. 169-175, 4 tables, March 1961, 10 refs.

An investigation of various chemical methods involving nonoxidizing conditions for separation of diamonds in stone meteorites was continued. A new technique which employs KHF_2 fusion was successful in recovering graphite from several meteorites. No diamonds were found in 17 meteorites using the methods described.--Auth.

3-3010. Honda, Masatake, and others. RADIO-ACTIVE SPECIES PRODUCED BY COSMIC RAYS IN IRON METEORITES: Geochim. et Cosmochim. Acta, v. 22, no. 2-4, p. 133-154, 8 tables, March 1961, 34 refs.

The radioactive isotopes Be^{10} , Al^{26} , Cl^{36} , K^{40} , and Mn^{53} have been measured in 4 Fe meteorites: Grant, Williamstown, Odessa, and Canyon Diablo. Each sample was recycled to constant activity, using a different chemistry for each recycle wherever pos-

sible. The samples were counted with a low-level β -counter, except for Mn^{53} whose X-rays were measured. The isotope ratios were approximately constant for each meteorite, except for Mn^{53} where a depth effect is visible. The cosmic-ray ages of Williamstown and Grant are about the same.--Auth.

3-3011. Stauffer, Heinz. COSMOGENIC ARGON AND NEON IN STONE METEORITES: Jour. Geophys. Research, v. 66, no. 5, p. 1513-1521, 2 figs., 5 tables, May 1961, 18 refs.

The abundance and isotopic composition of Ar and Ne in 6 chondrites and an achondrite have been measured. The results of previous investigations are confirmed, namely Ar/K ages from 1.3 to 4.6 billion years and exposure ages from 4 to 24 million years. It is shown that the differences of the ratios $\text{Ar}^{36}/\text{Ar}^{38}$ are due mainly to small amounts of trapped primordial or atmospheric Ar. Using the corrected Ar^{38} abundances, a value of 9.0 with a total spread of $\pm 20\%$ is found for the corrected $\text{Ne}^{21}/\text{Ar}^{38}$ ratios. The possibility of diffusive losses of cosmogenic rare gases is discussed.--Auth.

3-3012. Taylor, S. R., and others. STUDIES OF TEKTITE COMPOSITION - I. INVERSE RELATIONSHIP BETWEEN SiO_2 AND THE OTHER MAJOR CONSTITUENTS: Geochim. et Cosmochim. Acta, v. 22, no. 2-4, p. 155-163, 4 figs., 4 tables, March 1961, 13 refs.

The relation of SiO_2 to the other major constituents in tektites has been studied. For the australites, SiO_2 is shown to vary inversely with Al_2O_3 , FeO, MgO, CaO, and K_2O , but not Na_2O . These relationships are shown graphically and are statistically significant. The lack of a significant relation between SiO_2 and Na_2O is attributed to the poor quality of the Na determinations.

The averages of the australites, philippinites, billitonites, indochinites, moldavites, and Ivory Coast tektites show inverse relationships between SiO_2 and Al_2O_3 , MgO, FeO, and Na_2O ; similar relationships exist between SiO_2 and Al_2O_3 , MgO, FeO, CaO, and Na_2O for 67 analyses of individual tektites.

It is concluded that a significant inverse relationship exists between SiO_2 and the other major constituents in tektites, and that Al_2O_3 , FeO, MgO, CaO, Na_2O , and K_2O display positive correlations among themselves.--Auth.

3-3013. Cherry, R. D., and S. R. Taylor. STUDIES OF TEKTITE COMPOSITION - II. DERIVATION FROM A QUARTZ-SHALE MIXTURE: Geochim. et Cosmochim. Acta, v. 22, no. 2-4, p. 164-168, fig., table, March 1961, 19 refs.

The evidence of an inverse relation between SiO_2 and the other major constituents discussed in Pt. I of this series [see abstract above], together with the presence of particles of fused silica (lechatelierite) in tektites is explained on the basis of a physical mixing process. A mixture of 25% quartz and 75% of the nonvolatile (at $1,700^\circ\text{C}$.) constituents of shale is shown to produce a close match to the average composition of tektites.--Auth.

3-3014. Shaw, D. M. ELEMENT DISTRIBUTION LAWS IN GEOCHEMISTRY: Geochim. et Cosmochim. Acta, v. 23, no. 1/2, p. 116-134, fig., Apr. 1961, 31 refs.

Recent articles on element distributions have given insufficient attention to geological aspects of the problems, and have neglected to consider the effects of sampling, sample reduction, and analysis error on the interpretation of frequency distributions. No single probability function can be expected to suit all elements. These and other considerations lead to the proposal of 5 rules concerning trace element distributions which include Ahrens' proposed law in a revised form. The first 3 rules are based on theoretical considerations and require further experimental proof except in the case of certain ore deposits whose lognormal distribution is well established. It is recommended, however, that the lognormal law be used as the basis for discrimination tests in all cases.

- 1) The frequency distribution of concentrations of a camouflaged trace element in a homogeneous rock formed by a chemical equilibrium process can be considered as continuous probability functions with limits zero and ∞ .
- 2) The best probability function to use is the lognormal law, which is justified both by practical utility and theoretical considerations.
- 3) The previous rules also apply to those trace and minor elements which are largely concentrated in accessory or ore minerals of simple constitution. Many economic deposits are in this category. The Poisson function may also be convenient in this case, if the discontinuous distribution of mineral grains is considered.
- 4) The geochemical variance of a group of data is less than the measured variance, which should be corrected by subtracting manipulation variance (sampling, sample reduction, analysis).
- 5) The coefficient of variation c_g ($=s.d./mean$) of a small body of geochemical data provides a criterion for the choice between a normal and a lognormal law for subsequent statistical tests. When $c_g < 0.2$ either law will predict similar probabilities, but when $c_g > 0.2$ the lognormal law is more realistic. It is important to correct the observed relative variance c^2 (as in rule 4) to obtain c_g^2 , otherwise the choice will be biased towards a lognormal law.--Auth.

3-3015. Carmichael, Ian, and Alison McDonald. THE COLORIMETRIC AND POLAROGRAPHIC DETERMINATION OF SOME TRACE ELEMENTS IN THE STANDARD ROCKS G-1 AND W-1; *Geochim. et Cosmochim. Acta*, v. 22, no. 2-4, p. 87-93, 5 tables, March 1961, 18 refs.

The elements Bi, Cd, Co, Cu, Ni, Pb, Sn, and Zn have been determined colorimetrically and polarographically on the standard rocks G-1 and W-1, and the results are briefly compared with published data.--Auth.

3-3016. Lebedev, V.I. THE LAWS OF ISOMORPHISM. 1. THE DISTRIBUTION OF Mg, Fe, Mn, Ca, Sr, Ba, Li, K, Rb, AND SOME OTHER ELEMENTS IN MINERALS CRYSTALLIZING FROM MAGMAS; *Geokhimiya*, in translation, 1959, no. 6, p. 585-598, 2 figs., pub. 1961, 21 refs.

It is proved that in the first high-temperature stages of crystallization only elements which are able to strengthen the lattice to increase its energy enter as isomorphous admixtures (a capture of elements is taking place). In the following relatively low-temperature crystallization states, usually as a result of a concentration increase, elements which weaken the lattice and decrease its energy also enter as isomorphous admixtures (the elements are admitted).

The prediction of one or the other behavior of the element, especially in the case of heterovalent isomorphism, is a more complicated task than the known rules of V. M. Goldschmidt permit.--Auth.

3-3017. Zlobin, B.I. PARAGENESES OF DARK MINERALS IN ALKALIC ROCKS AND A NEW EXPRESSION FOR THE AGPAITIC COEFFICIENT; *Geokhimiya*, in translation, 1959, no. 5, p. 507-518, 3 figs., table, pub. 1960, 11 refs.

The ratio $(Na) = Na/Al-K = Na/4Al$ shows whether there is an excess or deficiency of Na with respect to the remainder of Al after its fixation by K. This is the main condition for the appearance of agpaite or plumbite dark mineral associations in alkaline rocks. The ratio may be used instead of the generally accepted agpaite coefficient, $Na+K/Al$, which does not differentiate unequivocally between the 2 associations.

The standard value of the agpaite coefficient, usually taken as 1, is actually 0.85 for the $Na/Al-K$ ratio and approximately 0.9 for the $Na+K/Al$ ratio. The lower value of the coefficient may be due to an excess of Al in the alkali feldspars and nepheline over the alkalis, which permits diadochic substitution of Ba^{2+} and Ca^{2+} in these minerals.

The agpaite alkaline rocks are those in which $(Na) > 0.85$, and the plumbite (or miaskitic in the case of nepheline syenites) are those in which $(Na) < 0.85$. The most typical dark minerals in the agpaite rocks are aegirine and soda amphiboles, and in the plumbite, biotite, augite, common amphiboles and magnetite.

The new form of the agpaite coefficient, $Na/Al-K$, is more sensitive to the changes in the parageneses of minerals than the $Na+K/Al$ ratio. The value of the latter is lower for the agpaite and higher for the plumbites as compared with the values of $Na/Al-K$ for the same rocks. The values of the old coefficient for different associations tend to overlap whereas the values of the proposed coefficient do not.

The presence or absence of aegirine and soda amphiboles in the alkaline rocks is not determined by the absolute content of Na_2O , Fe_2O_3 , or the Fe^{3+}/Fe^{2+} ratio, but depends on the ratio of Na and K to Al.

It is proposed that the alkaline granites be subdivided into agpaite, with $(Na) > 0.85$ and containing aegirine or alkali amphiboles, and plumbite, with $(Na) < 0.85$, containing biotite and common amphiboles. A similar division of alkaline syenites would also be useful.

The new form of the agpaite coefficient, $(Na) = Na/Al-K$, is in agreement with Loewinson-Lessing's hypothesis of distribution of the elements in the melt into groups corresponding to the composition of the future minerals during the period preceding the crystallization of the magma. It is doubtful that crystallization with the formation of the dark minerals at the end of the process is characteristic of the agpaite rocks only.--Auth.

3-3018. Solodov, N.A. CERTAIN REGULARITIES OF DISTRIBUTION OF RARE ELEMENTS IN SHARPLY ZONED GRANITE PEGMATITES; *Geokhimiya*, in translation, 1959, no. 4, p. 388-405, 3 figs., 3 tables, pub. 1960, 10 refs.

The distribution of the rare elements in the rare metal granite pegmatites is determined 1) by the spatial distribution of the principal rock-forming minerals, in other words, by the zonal structure of

the pegmatites; 2) by the EK values and ionization potentials of the rare elements; 3) by their initial concentration in the pegmatite melt; 4) by the distribution of the minerals capable of capturing a given rare element; and 5) by the chemical composition of the medium relative to point 5, when large amounts of the rare earths are present. Be for example becomes strongly dispersed and the character of its distribution is modified.--Auth. summ.

3-3019. Pavlenko, A.S., and others. CERTAIN REGULARITIES IN THE BEHAVIOR OF RARE EARTHS [AND] YTTRIUM IN MAGMATIC AND POST-MAGMATIC PROCESSES: *Geokhimiya*, in translation, 1959, no. 4, p. 357-380, 5 figs., 5 tables, pub. 1960, 10 refs.

The assemblage of the rare earths and Y in the minerals concentrators is determined by the proportion of individual elements during mineral formation and by their ability to migrate, not on the crystallochemical characteristics of the minerals. A simple linear relationship exists among the ratios of the light lanthanides (La-Sm) in the Ce minerals and some complex minerals. Variations in the content of the lanthanides and Y depend on the age of the rocks, their alkalinity, and the genesis of the minerals. The crystallochemical characteristics of minerals determine which part of the lanthanide-Y group may enter into a given mineral. The final products of magmatic evolution within a region become enriched in Y and the Y earths. Highly alkalic igneous complexes containing nepheline syenites are enriched in the Ce earths whatever the relative age of the rocks.

The genetic features of the processes of mineral formation have the following effects on the ratios in the lanthanide-Y group: a) a relative concentration of Y and the Y earths occurs in pegmatites and the marginal parts of the metasomatic zones; b) the shift towards the Ce earths increases with the intensity of metasomatism, and the rare earths as a group exhibit less mobility than Y; c) a more thorough removal of the rare earths is caused by potash than by soda metasomatism.

The Y earths and Y have greater mobility than do the Ce earths. Lesser mobility of the rare earths as compared with Y during infiltration metasomatism may be due to the difference between the atomic weights of the rare earths and Y. This insures the greater mobility of Y. A comparison of Zr-Hf, Nb-Ta, and RE-Y under similar conditions shows that the relationships among the rare earths and Y are more complex.--M. Russell.

3-3020. Surnina, L.V. CHEMICAL COMPOSITION OF THE GASES OF THE VOLCANO EBOKO: *Geokhimiya*, in translation, 1959, no. 5, p. 571-579, fig., 5 tables, pub. 1960, 7 refs.

The principal components of the fumarolic gases of Ebeko are H₂O, CO₂, HCl, H₂S, and SO₂. The concentration of O and N in these gases is negligible, indicating an almost complete absence of contamination of the samples with atmospheric O and their high quality.

As was to be expected, the fumarolic gases with surface temperatures lower than the boiling point of water are poor in water-soluble components (HCl, SO₂, CO₂, and H₂S) because of condensation of water vapor before emission at the surface. The peculiarity of the gases of Ebeko (relatively low temperature) is the considerable content of SO₂ and HCl, typical of gas mixtures emitted at higher temperatures directly

from the lavas at the moment of eruption (Klyuchevsky, Sheveluch, and other volcanoes). For the first time since the beginning of investigations of fumarolic gases of the Kamchatka and Kurile volcanoes, polythionic acids were found and quantitatively determined in the gases of Ebeko.--Auth. summ.

3-3021. Amirkhanov, Kh. I., and others. DIFFUSION OF ARGON IN SYLVITE: *Geokhimiya*, in translation, 1959, no. 6, p. 653-662, 5 figs., pub. 1961, 11 refs.

Experimental results of measurements of radiogenic Ar diffusion constants (D) at temperature 20-700°C. and its activation energy (E) and of electrical conductivity in the frequency range 0-20 mcg and its activation energy (E) are given for 2 specimens of sylvite. The mechanism of radiogenic Ar diffusion is found to differ from that of electrical conductivity and self-diffusion of K⁺. In the impurity conduction band, E = 47 kcal./mole, E = 22-30 kcal./mole. The diffusion constant extrapolated to 300°K is found to be 10⁻³⁰ cm.²/sec. As the most probable mechanism of radiogenic Ar diffusion, the diffusion across associated pair vacancies and Schottky defects is discussed. For one of the sylvite specimens low-temperature desorption-type Ar losses were found probably due to the mosaic crystal-structure.--Auth.

3-3022. Badalov, S.T., and M.P. Enikeev. GEO-CHEMISTRY OF CADMIUM IN THE AMALYK AND ALTYN-TOPKAN MINERALIZED AREAS OF THE KARAMAZAR REGION: *Geokhimiya*, in translation, 1959, no. 4, p. 406-415, 5 tables, pub. 1960, 24 refs.

Data are presented on the distribution of Cd in the Cu-Mo, polymetallic, and Au phases of the Almalıy mineralized area, and the polymetallic phases of the Altyn-Topkan area, Karamazar region. The Cd content of sphalerites here ranges from 0.08% to 1.91%. The largest economic concentration of Cd in the oxidized zone of polymetallic deposits is found in smithsonite, and the next largest in calcite.--M. Russell.

3-3023. Borisenok, L.A., and B.I. Zlobin. GALLIUM IN THE ALKALIC ROCKS OF THE SANDYK MOUNTAINS MASSIF (NORTHERN KIRGIZIYA): *Geokhimiya*, in translation, 1959, no. 6, p. 612-620, figs., 3 tables, pub. 1961, 10 refs.

The Ga distribution over various alkaline rocks of the complex massif and in some minerals has been studied. It is stated that the average Ga content in the massif is $19 \times 10^{-4}\%$ of Ga and that the Ga/Al ratio insignificantly deviates from the average value of 1.9×10^{-4} . In the course of the intrusion development some Ga-accumulation from the first stages (alkaline gabbroids and alkaline-earth syenites) to the final (nepheline syenites) is observed; this is in conformity with the Al increase in the same direction. The vein rocks are enriched in Ga compared to the intrusive rocks. Higher Ga-concentrations are detected in biotites and hornblende compared to earlier orthoclases and nepheline. This is discussed from a crystallochemical standpoint and taking into consideration the crystallization order of the rock minerals.--Auth.

3-3024. Gerasimovsky, V.I., and others. GALLIUM IN THE ROCKS OF THE LOVOZERO ALKALI

MASSIF: Geokhimiya, in translation, 1959, no. 5, p. 550-556, fig., 2 tables, pub. 1960, 6 refs.

The Ga content and the Ga-Al ratio in the nepheline syenites of the Lovozero massif are higher than in the rocks of the same type in other massifs.

In the Lovozero massif the highest Ga-Al ratio is found in the rocks of the third intrusive phase, indicating that Ga is concentrated in relation to Al in the late stages of the magmatic process. The lowest values of the ratio and the lowest Ga content characterize the rocks of the first intrusive phase.

The geochemical history of Ga in the rocks of the massif parallels that of Al and also, in part, of the trivalent Fe which Ga replaces diadochically in aegirine and other minerals.--Auth. concl.

3-3025. Ivanov, V. V., and N. V. Lizunov. **INDIUM IN SOME TIN DEPOSITS OF YAKUTIA:** Geokhimiya, in translation, 1959, no. 4, p. 416-427, 7 tables, pub. 1960, 10 refs.

In is a typomorphic element of the cassiterite-sulfide deposits of the Yana-Adychansk and Polousnensk regions. In is endocratically captured by the crystal lattices of minerals having mainly ionic bonding, such as cassiterite and wolframite, and by minerals with essentially covalent bonding, such as sphalerite, chalcopryrite, and stannite.

The content of In in the sulfides is usually 10 to 100 times as high as in cassiterite and wolframite, which contain from 0.001 to 0.005%, rarely 0.01% In. In all other analyzed minerals, In was either not detected at all or was found sporadically and in small amounts, as for example, in frankite, manganosiderite, and arsenopyrite.

The content and frequency of occurrence of In in chalcopryrite and stannite from the investigated regions are almost always as great as in sphalerites, and sometimes greater.

The main mass of In separated during the second and third stages of the formation of cassiterite-sulfide deposits. During the initial and latest stages of ore deposition, the concentration of In in the solutions was probably low, for even the mineral-concentrators formed during these stages have rather small In content.--Auth. summ.

3-3026. Rabinovich, A. V., and Z. A. Baskova. **THE DISTRIBUTION OF LEAD IN SOME GRANITOIDES OF EASTERN TRANSBAIKALIA:** Geokhimiya, in translation, 1959, no. 6, p. 663-667, table, pub. 1961, ref.

The Pb distribution of some granitoids of eastern Transbaikalia has been studied, a connection between them and the Zn-Pb, Mo, and Sn-W mineralization being assumed. Some tendency for a decrease in Pb balance at the expense of feldspars is noted at the transition from granitoids of the Zn-Pb zone to granitoids of the Sn-W metallogenic zone. Intrusions with which the Zn-Pb mineralization is connected are distinguished by a lower Pb content compared to magmatic formations with which a connection of the Mo and Sn-W mineralization is established.--Auth.

3-3027. Zhiron, K. K., and G. F. Ivanova. **THE DISTRIBUTION OF RHENIUM IN MOLYBDENITES FROM DEPOSITS OF A SERIES OF GENETIC TYPES:** Geokhimiya, in translation, 1959, no. 6, p. 628-634, 2 tables, pub. 1961, 5 refs.

The Re content is determined in 19 molybdenites

from deposits of 2 genetic types of the central Kazakhstan.

The average Re content in molybdenites from high temperature rare metal deposits (Kara-Oba, Akchatau, Airshoko, Dalnenskoe) is 2.5 p.p.m. at a fluctuation from 1 p.p.m. to 5.6 p.p.m. In deposits of the middle-temperature type (Shalgia) the average content is considerably higher and amounts to 32 p.p.m. at a fluctuation of 22 to 39 p.p.m.

A comparison with the data obtained with the results of molybdenite analyses from deposits of other types (skarn and Cu - molybdenite types) shows the existence of a general regularity in the increase of Re content in molybdenites with a fall of the temperature of deposit formation.--Auth.

3-3028. Volkov, V. P., and E. N. Savinova. **DISTRIBUTION OF RUBIDIUM AND THE K/Rb RATIO IN THE ROCKS OF THE LOVOZERO ALKALIC MASSIF:** Geokhimiya, in translation, 1959, no. 6, p. 635-642, 3 tables, pub. 1961, 11 refs.

The average Rb content in nepheline syenites of the Lovozero alkaline massif is 210 g./t. of Rb, and the K/Rb ratio is 195.

An increase of the Rb contents and a corresponding decrease of the K/Rb ratio in rocks of younger intrusive phases compared to more ancient phases is noted.--Auth.

3-3029. Kogarko, L. N. **DISTRIBUTION OF ALKALI METALS AND THALLIUM IN THE GRANITOIDS OF THE TURGOYAK PLUTON (MIDDLE URALS):** Geokhimiya, in translation, 1959, no. 5, p. 557-564, fig., 3 tables, pub. 1960, 13 refs.

The granitoids of the Turgoyak pluton were formed as a result of assimilation of the invaded rocks by the leucocratic granitic magmas. The content of the alkalis (Na, K, Li, Rb) and of Tl increases from the leucocratic granites (central parts of the pluton) to the biotite granites and decreases, with the exception of Li, in the granodiorites (near the contact zones of the pluton).

In the process of formation of the Turgoyak granitoids, the alkalis and Tl were carried out into the peripheral zones of the pluton and into the enclosing rocks. The removal of these elements varied in intensity. The most mobile were Li, K, and Tl.

The decrease in the Rb/Tl ratio in the rocks of the Turgoyak pluton from 180 in the leucocratic granites to 70 in the granodiorites is characteristic and indicates the greater mobility of Tl.

The difference in the behavior of Rb and Tl is probably related to the difference in the electronegativity of these elements.--Auth. summ.

3-3030. Brooks, R. R., and L. H. Ahrens. **SOME OBSERVATIONS ON THE DISTRIBUTION OF THALLIUM, CADMIUM AND BISMUTH IN SILICATE ROCKS AND THE SIGNIFICANCE OF COVALENCY ON THEIR DEGREE OF ASSOCIATION WITH OTHER ELEMENTS:** Geochim. et Cosmochim. Acta, v. 23, no. 1/2, p. 100-115, 2 figs., 8 tables, Apr. 1961, 40 refs.

Cd, Tl, and Bi have been estimated in 44 rock samples, using the anion exchange-spectrochemical procedure described by Brooks et al. Estimates of the crustal abundances of these elements have been made on the basis of 2 parts granite (plus compositional equivalent) and 1 part basalt (plus gabbro and diabase), and are as follows: Cd (0.08 p.p.m.), Tl

(0.7 p.p.m.), and Bi (0.17 p.p.m.). The Cd value is lower than previous estimates. The Tl value is also lower than other estimates but as it is based on quite extensive data (recent data of Russian and Japanese workers, plus data from this paper) it is suggested with considerable confidence.

The Rb-Tl association is considered in some detail. The association of these 2 elements is in certain respects closer than that of the classical pair K-Rb. The presence of a significant degree of covalency in the Tl-O bond may slightly but distinctly influence the Rb-Tl association. A high degree of covalency is evidently present in the Cd-O bond and is the probable reason why a Cd-Ca association (radii of Cd^{2+} and Ca^{2+} almost identical) is virtually non-existent. The significance of the presence of a high degree of covalency in the metal-O bonds of certain other elements is also discussed.

Possible high crustal enrichment of Tl and Bi, but not Cd, is noted.--Auth.

3-3031. Voskresenskaya, N. T. GEOCHEMISTRY OF THALLIUM AND RUBIDIUM IN IGNEOUS ROCKS: Geokhimiya, in translation, 1959, no. 6, p. 599-611, 7 tables, pub. 1961, 18 refs.

The study and the analysis of the Rb/Tl ratio for rocks of the young magmatic hearth of Tyzny-Auz as well as for ancient rocks of this region confirm the geological conclusions of a common magmatic source for young intrusive and effusive rocks of Tyzny-Auz and establish the difference of these rocks and the ancient rocks of the Chief mountain range.

The strong fluctuations of the Rb/Tl ratio in some samples of leucocratic granitoids from 60 to 340 as well as the analogous fluctuations of this ratio in the contact-altered varieties of biotitic granite allow to advance the assumption on the difference in the conditions of the formation of the leucocratic and biotitic granites. Some decrease in Rb/Tl ratio in leucocratic granitoids and in the nearby-contact parts of the biotitic granite (compared to normal biotitic granite) bears witness of the enrichment of the latter in Tl compared to Rb. For the contact-altered granite this enrichment is conditioned by the removal of Tl from the center of the intrusive to the endocontact.

The difference in the character of the Tl and Rb bond in silicates as well as the high volatility of the haloid Tl compounds lead to the separation of Rb and Tl, and hence, to the disturbance of constancy of the Rb/Tl ratio in rocks which are products of assimilation, hybridism, or were subjected to hydrothermal action connected with the metasomatic alteration of K minerals.--Auth.

3-3032. Saprykina, T. V. DISTRIBUTION OF URANIUM IN THE ROCKS OF THE LOVOZERO ALKALI MASSIF: Geokhimiya, in translation, 1959, no. 5, p. 565-570, table, pub. 1960, 8 refs.

There is a regular increase in the U content from the rocks of the first intrusive phase to those of the third and later phase. The content of U in the monchiquite dikes of the lamprophyre group (fourth intrusive phase) is much lower than in the nepheline syenites of the first 3 phases. The rocks of each intrusive phase have a higher U content if they contain lovozerite, loparite, or eudialyte. The average U content in the nepheline syenites of the Lovozero massif is 16 g./ton, i.e. 4 times as high as the average U content in granites.--Auth. summ.

3-3033. Abramovich, I. I. URANIUM AND THORIUM IN THE INTRUSIVE ROCKS OF CENTRAL AND

WESTERN TUVA: Geokhimiya, in translation, 1959, no. 4, p. 442-450, 4 figs., table, pub. 1960, 12 refs.

The granitoids of the Tannu-ola complex most closely resemble the granitoids of type V but differ from them in having a somewhat higher Th/U ratio. The granites of the Chugekat complex, on the other hand, have a somewhat lower Th/U ratio as compared with the granitoids of type II. The granites of the Khovaksky complex correspond to the least radioactive varieties of the granitoids of type V. The granitoids of the Torgalyk complex occupy a more or less intermediate position among the granites of types I, II, and V. The main mass of granites of the Syukhol complex corresponds to the granites of type I, although the more radioactive massifs of the complex should be referred to massifs of type III, the so-called rare metal type. The granites of the Yustyd complex belong entirely to the rare metal type. There are no granite massifs in central and western Tuva which even remotely resemble massifs of type IV.

The more general conclusions concerning regional radiochemical characteristics of Tuva are: the granitoids of central and western Tuva belong entirely to the types with low and medium radioactivity. Predominant among the granites of Tuva are rocks with average or Clarke U and Th content and a somewhat higher than normal Th-U ratio.--Auth. concl.

3-3034. Filippov, M. S., and L. V. Komlev. URANIUM AND THORIUM IN THE GRANITOIDS OF THE MIDDLE DNEPR REGION: Geokhimiya, in translation, 1959, no. 5, p. 535-549, 4 figs., 6 tables, pub. 1960, 16 refs.

In the middle Dnepr region there are 3 granitoid complexes different in age, composition, and geochemical characteristics. The evolution in the composition of the granitoids of the 3 complexes from older to younger consisted in the decrease in Na, Ca, and Mg content and increase in K, silica, the radioactive elements, U, and Th.

According to content of the most characteristic accessory minerals, the granitoids are divisible into 3 types: a) the allanite-sphene type, which includes the granodiorites and plagiogranites of the oldest complex and the amphibole-biotite varieties of the Kirovograd-Zhitomir granites; b) the monazite-garnet type, which includes the biotite granites of the Kirovograd-Zhitomir complex and the black quartz granites of the Ingults River region; and c) the thorite-molybdenite type, represented by the Tokovskiy granites.

The allanite-sphene granites are the poorest in the radioactive elements. U and Th in these rocks are partially concentrated in the accessory minerals: zircon, sphene, epidote, apatite, and allanite. A part of these elements is present in the dispersed state, in the essential minerals. The monazite-bearing granites are Th-bearing. Their high Th content is due to the accumulation of the accessory monazite. Monazite and zircon are the main concentrators of U and Th in granites of this type. The Th-bearing granites are still more pronouncedly Th-bearing rocks, but they also have a relatively high U content. U and Th in these granites are concentrated almost entirely in the accessory minerals, with thorite and zircon carrying 90% of the total content of these elements.

The geochemical data confirm previously established geochemical regularities of distribution of U and Th, i.e. their preferential concentration in the acid alkali-rich granitoids, the progressive concentra-

tion of these elements in the end products of the differentiation of granitic magma, the sharp change in the behavior of U and Th in passing from the orthomagmatic to the postmagmatic stage, and the important role of the postmagmatic alteration of the rocks in the redistribution of the radioactive elements.

The Tokovsky granites and their derivatives are enriched in Th on a regional scale and there are 3 varieties of thorite: thorite, phosphothorite, and uranothorite, among their accessory minerals.--M. Russell.

3-3035. Weber, Jon N., and Gerard V. Middleton. **GEOCHEMISTRY OF THE TURBIDITES OF THE NORMANSKILL AND CHARNY FORMATIONS - I. EFFECT OF TURBIDITY CURRENTS ON THE CHEMICAL DIFFERENTIATION OF TURBIDITES:** *Geochim. et Cosmochim. Acta*, v. 22, no. 2-4, p. 200-243, 3 figs., 22 tables, March 1961, 31 refs.

Thirty-one Normanskill [Ordovician] graywackes and 24 Quebec group (Charny formation [Cambrian]) arkoses have been analyzed spectrographically to determine the concentrations of Ag, B, Ba, Be, Co, Cr, Cu, Ga, La, Mg, Mn, Mo, Ni, Sc, Sr, Ti, V, Y, and Zr, of which Ag, Be, La, Mo, and Y were rarely or never detected. The analyses indicate the nature and magnitude of chemical variations within turbidite beds, between beds in a stratigraphic section, between sections, and between formations.

Despite the grading of turbidite strata, variation in concentration from the top to the bottom of a bed is small except for Zr which is relatively concentrated at the base. Variation between beds and between sections is greatest as a result of the relative distances of the samples from successive turbidity flows, and variation between formations is small, reflecting the uniformity of turbidite sediments derived from many terrestrial rock types with little chemical differentiation.--Auth.

3-3036. Weber, Jon N., and Gerard V. Middleton. **GEOCHEMISTRY OF THE TURBIDITES OF THE NORMANSKILL AND CHARNY FORMATIONS - II. DISTRIBUTION OF TRACE ELEMENTS:** *Geochim. et Cosmochim. Acta*, v. 22, no. 2-4, p. 244-288, 9 figs., 6 tables, March 1961, 6 refs.

Thirty-one Normanskill graywackes and 24 Quebec group (Charny formation) arkoses, of turbidite origin, have been analyzed spectrographically to determine the concentrations of Ag, B, Ba, Be, Co, Cr, Cu, Ga, La, Mg, Mn, Mo, Ni, Sc, Sr, Ti, V, Y, and Zr.

The distribution of the trace elements and of Mg is shown by histograms. One graywacke was disaggregated into 4 major constituents, carbonate, clay, quartz-feldspar, and heavy minerals, illustrating what each fraction contributes to the chemical composition of the rock. Correlation of chemical and mineral composition is attempted, statistical analysis was carried out showing correlations between all pairs of elements and the role of each element in the turbidites is discussed.--Auth.

3-3037. Newton, R., and G. F. Round. **THE DIFFUSION OF HELIUM THROUGH SEDIMENTARY ROCKS:** *Geochim. et Cosmochim. Acta*, v. 22, no. 2-4, p. 106-132, 6 figs., March 1961, 14 refs.

He is produced by the radioactive decay of the nuclides of certain minerals, and it is commonly assumed that a portion of this He migrates from its

source through overlying rocks to the atmosphere. In this paper the effect of diffusion control on the migration of He in sediments has been evaluated by the construction of a series of mathematical models to represent a wide range of practical situations. These models range from that with a single infinite, uniform layer of sediment to that with n different, finite uniform layers of sediments. The problem has been reduced to one-dimensional diffusion with the Precambrian basement rocks as the source of He, and the diffusion equation has been solved for this system with differing boundary conditions. The n -layer models have been evaluated by a series of suitable approximations at each of the interfaces between the layers and in this way the relationship between the He concentrations in successive layers has been obtained. The effect of these approximations has been illustrated by using them to evaluate some of the single-layer models. Some of the single-layer and 2-layer models have been evaluated using representative values for the parameters introduced in the analysis.--Auth.

3-3038. Mikhailov, A. S. **CERTAIN CHARACTERISTICS OF THE GEOCHEMISTRY OF MOLYBDENUM IN THE SOILS OF CENTRAL KAZAKHSTAN:** *Geokhimiya*, in translation, 1959, no. 5, p. 529-534, 2 figs., pub. 1960, 7 refs.

The main characteristics of the geochemistry of Mo in the soils of central Kazakhstan are:

1) A considerable part of Mo present in soils occurs in the form of soluble compounds. This Mo is derived from the oxidized zones and is continually replenished.

2) The following features are observed in the separation of the soluble from the insoluble Mo compounds: a) The areas of high relief with immature soils have small amounts of soluble Mo (less than 5% of the total). b) In the valleys and other negative landscape forms the soluble Mo salts are concentrated with other easily soluble salts. The amount of soluble Mo may reach 100% of its total content. c) The gentle foothill slopes and small hills occupy an intermediate position between these 2 extremes.

3) The concentration of mobile Mo in the negative landscape forms isolated from the mineralized areas may reach several hundredths of 1%. The fluctuation in the concentration of Mo in time, the several-fold change in its content depends on the amount and regime of precipitation.--Auth. summ.

3-3039. Alekperov, R. A., and G. Kh. Efendiev. **ON THE URANIUM CONTENT IN PETROLEUM:** *Geokhimiya*, in translation, 1959, no. 6, p. 621-627, 3 figs., table, pub. 1961, 10 refs.

The U content is determined in petroleum of some Azerbaijanian deposits bound to different series of Tertiary sediments. The U determination was carried out in petroleum ash with the aid of the luminescence method.

U is a component of all the studied petroleum in which the U content varies from 1×10^{-4} to $10^{-2}\%$ in ash or from 1×10^{-7} to 5×10^{-3} g./l. of petroleum. The U content and the ash content of petroleum are inversely related indicating a bond between the U content and the organic petroleum components.

The character of U distribution in the system petroleum - sheet waters depends on the chemical composition of the latter. In the above mentioned system the equilibrium is always shifted towards the petro-

leum but more pronounced in the case of hard waters.

It is established that the decrease of the U content, being extracted by petroleum from artificial solutions, is in conformity with the following salt series contained in solutions: $\text{CaCl}_2\text{-MgCl}_2\text{-NaHCO}_3$.--Auth.

3-3040. Weiss, Herbert V., and John A. Reed. DETERMINATION OF COBALT IN SEAWATER: Jour. Marine Research, v. 18, no. 3, p. 185-188, table, Nov. 1960, 6 refs.

Co has been isolated from sea water by cocrystallization with α -nitroso- β -naphthol. Quantitative determination by a nitroso-R-salt method for each of 2 sea-water samples has indicated the Co content to be 0.038 $\mu\text{g/l}$ after radiometric correction for losses incurred in the isolation process.--Auth.

3-3041. Thompson, Thomas G., and Taivo Laevastu. DETERMINATION AND OCCURRENCE OF COBALT IN SEA WATER: Jour. Marine Research, v. 18, no. 3, p. 189-193, table, Nov. 1960, 13 refs.

Methods have been investigated to ascertain the most desirable procedure for determining the trace concentrations of Co in sea water. The nitroso-R-salt method of Sandell was adopted and modified for sea water analysis. Samples of water were secured with the nonmetallic water sampler of Thompson and Chow. Preliminary studies of the waters of the San Juan archipelago and of Puget Sound showed Co concentrations ranging from 0.0039 to 0.0054 $\mu\text{g-at Co/l}$.--Auth.

3-3042. Collins, Peter, and Harvey C. Diehl. TRIPYRIDYLTRIAZINE, A REAGENT FOR THE DETERMINATION OF IRON IN SEA WATER: Jour. Marine Research, v. 18, no. 3, p. 152-156, fig., table, Nov. 1960, 4 refs.

Fe in the parts per billion range in which it occurs in sea water, can be determined spectrophotometrically with 2,4,6-tripyridyl-s-triazine (TPTZ). The intense violet compound formed by TPTZ and the ferrous ion is extractable into nitrobenzene if sodium perchlorate be added to the solution. The extraction affords a means of concentrating the Fe from a large sample into a small volume of nitrobenzene for spectrophotometric measurement. The extraction also provides a means of removing the Fe impurities from the solutions of the various reagents required, reducing agent and buffer, and thus of reducing the blank essentially to zero. If certain precautions are observed during analysis, particularly with respect to the cleaning of glassware, the absolute error is less than 0.1 $\mu\text{g Fe/l}$.--Auth.

3-3043. Pate, John B., and Rex J. Robinson. THE (ETHYLENEDINITRIL)-TETRAACETATE TITRATION OF CALCIUM AND MAGNESIUM IN OCEAN WATERS. II. DETERMINATION OF MAGNESIUM: Jour. Marine Research, v. 19, no. 1, p. 12-20, 6 tables, March 1961, 19 refs.

Modifications of the EDTA titration of total hardness have been evaluated for use in determining Mg in sea water. In this procedure EDTA is the titrant, Eriochrome Blue Black B the indicator, and ethanolamine the buffer. Various conditions necessary for accurate sea water titrations have been established. A mean Mg-chlorinity ratio of 0.06689 was obtained when 30 sea water samples were titrated.--Auth.

3-3044. Turekian, Karl K., and Richard L. Armstrong. MAGNESIUM, STRONTIUM, AND BARIUM CONCENTRATIONS AND CALCITE-ARAGONITE RATIOS OF SOME RECENT MOLLUSCAN SHELLS: Jour. Marine Research, v. 18, no. 3, p. 133-151, 4 figs., 6 tables, Nov. 1960, 17 refs.

Approximately 100 recent molluscan shells have been analyzed spectrographically for Mg, Sr, and Ba; their calcite-aragonite ratios were determined by X-ray diffraction. The methods are described in detail. The most important parameter controlling the concentration of these trace elements in calcium carbonate shells appears to be generic association rather than water temperature or calcite-aragonite ratio of the shell. As a group, snails are higher in Mg and lower in Sr and Ba than clams. The "fractionation ratio" of the trace alkaline-earth elements ($f = \text{Sr/Ca}_{\text{shell}}/\text{Sr/Ca}_{\text{sea}}$) increases from 0.00041 for Mg to 0.18 for Sr to 1.6 for Ba, indicating other than a simple ionic size control in trace element incorporation into the shells.--Auth.

3-3045. Nutt, David C., and others. DISSOLVED NITROGEN IN WEST GREENLAND WATERS: Jour. Marine Research, v. 19, no. 1, p. 6-11, 3 figs., March 1961, 6 refs.

The N tension in several water masses in the W. Greenland coastal region departs only about 5% from the value of the atmosphere. Significantly higher values of N tension were found in the upper layers of waters near glacier fronts. These values are attributed to the solution of gases trapped in the glacier ice and released to the water under considerable hydrostatic pressure.--Auth.

3-3046. Feth, John H., and others. AQUA DE NEY, CALIFORNIA, A SPRING OF UNIQUE CHEMICAL CHARACTER: Geochim. et Cosmochim. Acta, v. 22, no. 2-4, p. 75-86, map, 3 tables, March 1961, 19 refs.

The chemistry of water of Aqua de Ney, a cold spring of unusual character located in Siskiyou County, California, has been reexamined as part of a study of the relation of water chemistry to rock environment. The water has a pH of 11.6 and a silica content of 4,000 parts per million (p.p.m.), the highest values known to occur in natural ground waters.

The rocks exposed nearby consist of 2 volcanic sequences, one predominantly basaltic in composition, the other highly siliceous. Neither these rocks nor the sedimentary and igneous rocks presumed to underlie the area at depth seem to offer explanation of the unusual mineralization which includes 240 p.p.m. of B, 1,000 p.p.m. of sulfide (as H_2S), and 148 p.p.m. of ammonia nitrogen (as NH_4) in a water that is predominantly sodium chloride and sodium carbonate in character.

By analogy, it is assumed that water from Aqua de Ney is the product of an initial mixture of connate sea water with a calcium magnesium sulfate water. It is postulated that ion exchange has increased the content of Na and reduced that of Ca and Mg, and that sulfate reduction has brought about the high alkalinity, high pH, and high content of sulfide. The large silica value is explained as the result of solution of silica by water having the high pH observed.--Auth.

3-3047. Tyutina, N. A., and others. AN EXPERIMENT IN BIOGEOCHEMICAL SAMPLING AND THE

METHOD OF DETERMINATION OF NIOBIUM IN PLANTS: Geokhimiya, in translation, 1959, no. 6, p. 668-675, 2 figs., 3 tables, pub. 1961, 10 refs.

An increase of the Nb content in plants from 0-3 μg . to 50-70 μg . (per 5 g. of dry plant material) may serve as an indication for search in geological-prospecting work.

It is found that in the region under examination *Rubus arcticus* L., *Chamaenerium angustifolium* L., *Vaccinium myrtillus* L., and *Rubus chamaemorus* L. show the greatest ability for Nb extraction from the soil. Methods of the determination of Nb, both from ash and from dried plant material are worked out.--Auth.

3-3048. Aidinyan, R. Kh. **DISTRIBUTION OF RARE ALKALIES IN SOIL COLLOIDS AND THE PARTICIPATION OF PLANTS IN THIS PROCESS:** Geokhimiya, in translation, 1959, no. 4, p. 428-441, 9 tables, pub. 1960, 16 refs.

Soils and the plants growing on them were analyzed for rare alkali content. It was established experimentally for the different types of soils that the largest amount of the rare alkalies accumulates in the colloids ($<0.2\mu$ fraction), and a smaller amount in the pre-colloidal fraction ($2-0.2\mu$) of the soils. In many cases no Rb or Cs was found in the residue left after the separation of particles $<2\mu$ in diameter. While it was possible to determine Cs quantitatively in the colloids, very often no Cs was detected in crude samples of the same soil. The relative content of the rare alkalies in the soil as a whole is very much smaller than in its fine fractions. As a rule, the smaller the diameter of the particles, i.e., the greater the degree of dispersion, the greater the accumulation of the rare alkalies. It is suggested that adsorption of the rare alkalies on the inner surface of the colloidal particles in the interlayer spaces is one of the forms of fixation of the rare alkalies in soils. It has been shown that heating of the soil colloids changes Rb from exchangeable to nonexchangeable form, evidently because the dehydrated ion enters into the open octahedral spaces of the crystal lattices. Exceptions to this are colloids containing large amounts of the sesquioxides (colloids separated from the lower horizons of red and yellow soils).

A considerable portion of the rare alkalies, amounting to 10-30% of the total content, exists in a mobile form (soluble in 0.2N HCl).

The Rb content in plants (in tea leaves, steppe vegetation, etc.) is correlatable with their K content. Like K, Rb accumulates in the tender vegetative and reproductive organs of the plants. It is possible that in plants Rb may substitute for K. The "flesh" of a tea plant always contains more Rb and Cs than the coarse leaves. No Cs was found in the ash of old leaves, flowers, and roots of the tea plant. Under natural conditions, under the effect of atmospheric agents and geological processes, Li, Rb, and Cs are intensively leached out of dead leaves on the forest floor, and out of dead roots, so that the soil is enriched in these elements, especially its humic horizon. During the formation of soil, this process gives an increased content of the rare alkalies to the soil colloids.--Auth. summ.

3-3049. Russell, R. D., and others. **ANOMALOUS LEADS FROM BROKEN HILL, AUSTRALIA:** Jour. Geophys. Research, v. 66, no. 5, p. 1495-1498, 2 figs., 2 tables, May 1961, 5 refs.

Thackaringa-type leads from Broken Hill, Australia, occurring in vein-type deposits. The points representing these leads lie, within very narrow limits, along a straight line on a $\text{Pb}^{207}/\text{Pb}^{204}$ plot. This graph proves, beyond serious doubt, the contention made in a previous paper in 1957, that the Thackaringa-type leads at Broken Hill are a series of anomalous leads.

The isotopic analyses are interpreted to indicate that the Thackaringa-type leads were deposited at a time not earlier than $1,190 \pm 35$ million years ago and that the source material for the anomalous radiogenic Pb component came into existence not before $1,970 \pm 50$ million years ago but not later than $1,190 \pm 35$ million years ago.

Approximate values for the Th-U ratios of the anomalous Pb sources are included.--Auth.

3-3050. Stieff, L. R., and Thomas W. Stern. **GRAPHIC AND ALGEBRAIC SOLUTIONS OF THE DISCORDANT LEAD-URANIUM AGE PROBLEM:** Geochim. et Cosmochim. Acta, v. 22, no. 2-4, p. 176-199, 5 figs., table, March 1961, 27 refs.

U-bearing minerals that give Pb-U and Pb-Pb ages that are essentially in agreement, i.e. concordant, generally are considered to have had a relatively simple geologic history and to have been unaltered since their deposition. The concordant ages obtained on such materials are, therefore, assumed to approach closely the actual age of the minerals. Many U-bearing samples, particularly U ores, give the following discordant age sequences: $\text{Pb}^{206}/\text{U}^{238} < \text{Pb}^{207}/\text{U}^{235} < \text{Pb}^{207}/\text{Pb}^{206}$ or, less frequently, $\text{Pb}^{207}/\text{Pb}^{206} < \text{Pb}^{207}/\text{U}^{235} < \text{Pb}^{206}/\text{U}^{238}$. These discordant age sequences have been attributed most often to uncertainties in the common Pb correction, selective loss of radioactive daughter products, loss or gain of Pb or U, or contamination by an older generation of radiogenic Pb.

The evaluation of discordant Pb isotope age data may be separated into 2 operations. The first operation, with which this paper is concerned, is mechanical in nature and involves the calculation of the different possible concordant ages corresponding to the various processes assumed to have produced the discordant ages. The second operation is more difficult to define and requires, in part, some personal judgment. It includes a synthesis of the possible concordant age solutions with other independent geologic and isotopic evidence. The concordant age ultimately chosen as most acceptable should be consistent not only with the known events in the geologic history of the area, the age relations of the enclosing rocks, and the mineralogic and paragenetic evidence, but also with other independent age measurements and the isotopic data obtained on the Pb in related or associated nonradioactive minerals.

The calculation of the possible concordant ages from discordant age data has been greatly simplified by Wetherill's graphical method of plotting the mole ratios of radiogenic $\text{Pb}^{206}/\text{U}^{238}$ ($\text{N}_{206}/\text{N}_{238}$) vs. radiogenic $\text{Pb}^{207}/\text{U}^{235}$ ($\text{N}_{207}/\text{N}_{235}$) after correcting for the contaminating common Pb^{206} and Pb^{207} . The linear relationships noted in this graphical procedure have been extended to plots of the mole ratios of total $\text{Pb}^{206}/\text{U}^{238}$ ($\text{T}_{206}/\text{N}_{238}$) vs. total $\text{Pb}^{207}/\text{U}^{235}$ ($\text{T}_{207}/\text{N}_{235}$). This modification permits the calculation of concordant ages for unaltered samples using only the $\text{Pb}^{207}/\text{Pb}^{206}$ ratio of the contaminating common Pb.

If isotopic data are available for 2 samples of the same age, x and y, from the same or related deposits or outcrops, graphs of the normalized difference

This paper presents the isotopic analyses of 7

ratios

$$\left[\frac{(N_{206}/N_{204})_x - (N_{206}/N_{204})_y}{(N_{238}/N_{204})_x - (N_{238}/N_{204})_y} \right]$$

vs.

$$\left[\frac{(N_{207}/N_{204})_x - (N_{207}/N_{204})_y}{(N_{235}/N_{204})_x - (N_{235}/N_{204})_y} \right]$$

can give concordant ages corrected for unknown amounts of a common Pb with an unknown Pb^{207}/Pb^{206} ratio. (If Th is absent the difference ratios may be normalized with the more abundant index isotope, Pb^{208} .) Similar plots of the normalized, difference ratios for 3 genetically related samples ($x - y$) and ($x - z$), will give concordant ages corrected, in addition, for either one unknown period of past alteration or initial contamination by an older generation of radiogenic Pb of unknown Pb^{207}/Pb^{206} ratio.

Practical numerical solutions for all of the concordant age calculations are not currently available. However, the algebraic equivalents of these new graphical methods give equations which may be programmed for computing machines. For geologically probable parameters the equations of higher order have 2 positive real roots that rapidly converge on the exact concordant ages corrected for original radiogenic Pb and for loss or gain of Pb or U. Modifications of these general age equations expanded only to the second degree have been derived for use with desk calculators.

These graphical and algebraic methods clearly suggest both the type and minimum number of samples necessary for adequate mathematical analysis of discordant Pb isotope age data. This mathematical treatment also makes it clear that discordant Pb isotope data alone cannot provide the basis for the choice of one of the possible concordant age solutions. The new equations, in particular, provide an incentive to improve our physical constants, analytical techniques and sampling methods in order that we may derive all of the useful geologic information that is available in a comprehensive Pb isotope age study. --Auth.

3-3051. Fairbairn, H. W., and others. THE RELATION OF DISCORDANT Rb-Sr MINERAL AND WHOLE ROCK AGES IN AN IGNEOUS ROCK TO ITS TIME OF CRYSTALLIZATION AND TO THE TIME OF SUBSEQUENT Sr^{87}/Sr^{86} METAMORPHISM: *Geochim. et Cosmochim. Acta*, v. 23, no. 1/2, p. 135-144, 13 figs., table, Apr. 1961, 8 refs.

Interpretation of discordant Rb-Sr ages of coexisting biotite and K-feldspar in igneous rocks, mostly from Sudbury, Ontario, has been attempted using supplementary whole-rock ages. Following a model proposed by Compston and Jeffery, it is postulated that, if the igneous body is a closed system, and a post-crystallization thermal event interrupts the accumu-

lation of Sr^{87} in biotite and K-feldspar, the whole-rock analysis will give the true age and, owing to diffusion of radiogenic Sr out of biotite and K-feldspar, the apparent ages of these 2 minerals would be less than the whole-rock age. The common intersection of the 3 radiogenic growth lines (Sr^{87}/Sr^{86} plotted against age) gives the time of metamorphism. For the majority of the 12 examples the model offers an apparently valid explanation of the discrepant ages in terms of known field relations and 2 orogenic events at 1.2 billion years and 1.6 billion years. --Auth.

3-3052. Evernden, Jack F., and others. ON THE EVALUATION OF GLAUCONITE AND ILLITE FOR DATING SEDIMENTARY ROCKS BY THE POTASSIUM-ARGON METHOD: *Geochim. et Cosmochim. Acta*, v. 23, no. 1/2, table, p. 78-99, Apr. 1961, 10 refs.

K-Ar dates of stratigraphically known biotite-bearing tuffs, lava flows, and intrusions when used as controls show that illite and glauconite samples selected carefully with regard to geologic history and prepared properly are suitable for obtaining dates almost as accurate as those from igneous biotite. A tentative time-scale is constructed for the Tertiary epochs. --Auth.

3-3053. Freas, Donald H. TEMPERATURES OF MINERALIZATION BY LIQUID INCLUSIONS, CAVE-IN-ROCK FLUORSPAR DISTRICT, ILLINOIS: *Econ. Geology*, v. 56, no. 3, p. 542-556, 2 figs., 3 tables, May 1961, 16 refs.

Temperatures of vapor bubble disappearance of liquid inclusions in fluorite, sphalerite, and quartz from the Deardorff and Victory mines of the Cave-in-Rock fluor spar district were determined. Inclusions were studied in minerals of both principal stages of deposition indicated in the deposits. The data obtained indicate that ore deposition took place in the temperature range of $94^{\circ}C.$ to $142^{\circ}C.$, assuming a pressure correction of $+13^{\circ}C.$, and that temperature oscillated during mineralization. Fluorite, the first mineral to be deposited in each stage, was deposited in the upper part of the temperature range, and sphalerite and quartz, which followed fluorite in each stage, were deposited at lower temperatures. Petroleum inclusions in fluorite show considerably lower temperatures of vapor bubble disappearance than aqueous inclusions, but petroleum inclusions cannot be used for temperature determinations, because pressure corrections cannot be estimated. The basic assumptions of the method are evaluated with respect to the deposits and it is concluded that no errors of first order magnitude are expected. The apparent variation in temperature during mineralization is tentatively interpreted as the result of 2 pulsations of hydrothermal solutions from a single source. --Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Geochemistry 3-3009, 3-3016; Mineral Deposits 3-3125, 3-3126, 3-3129, 3-3133; Engineering Geology 3-3153.

3-3054. Amstutz, G. C. THE PREPARATION AND USE OF POLISHED THIN SECTIONS: *Am. Mineralogist*, v. 45, no. 9/10, p. 1114-1116, 6 illus., Sept. - Oct. 1960, 3 refs.

Very useful polished thin sections are easily made

by holding, with 50-100 g. pressure, an uncovered, slightly thick section for 5 to 20 min. on a soft lap coated with 1 or 0.5 micron size abrasives. --D. O. Emerson.

3-3055. Olcott, Gordon W. PREPARATION AND USE OF A GELATIN MOUNTING MEDIUM FOR REPEATED OIL IMMERSION OF MINERALS: *Am.*

Mineralogist, v. 45, no. 9/10, p. 1099-1101, Sept. - Oct. 1960, 4 refs.

A 1% gelatin solution is spread on a petrographic slide which has been heated to 80°C. After the gelatin has dried a few drops of a mixture of 5 parts acetone, 2 parts 2% formalin, and 10 parts water are used to soften the gelatin. After the mineral grains are sprinkled on, the mount is dried at 80°C. Acetone or carbon tetrachloride are used to wash the oils from the slide without affecting the mineral grains.--D. O. Emerson.

3-3056. Serratos, J. M. DEHYDRATION STUDIES BY INFRARED SPECTROSCOPY: Am. Mineralogist, v. 45, no. 9/10, p. 1101-1104, 8 graphs, Sept. - Oct. 1960, 2 refs.

A decrease in the infrared absorption spectra peaks at both 3,630 and 919 for montmorillonite from Tidinit, Morocco, and at 3,610 and 820 for nontronite from Utah is evident when they are heated at temperatures increasing from 100°C to 625°C. The lower frequency peak is correlated with the flexion associated with the O-H stretching frequency near 3,600 cm.⁻¹. The heavier octahedral ion neighbors decrease the frequency. It is suggested that a less pronounced peak at 860 cm.⁻¹ in the nontronite pattern is due to hydroxyls with one Fe and one Al or Mg neighbor.--D. O. Emerson.

3-3057. Sorem, Ronald K. X-RAY DIFFRACTION TECHNIQUE FOR SMALL SAMPLES: Am. Mineralogist, v. 45, no. 9/10, p. 1104-1108, 5 diags., Sept. - Oct. 1960, 2 refs.

Mineral grains which can be scratched from a specimen by using a sharp diamond stylus are mounted on a pointed gelatin fiber. The fiber, which is cut from a flattened capsule produces little amorphous scattering and slightly moistened grains adhere to it. By using the small (57.3 mm.) Debye-Scherrer camera with a spacer to partially withdraw the exit tube, permitting reflections down to 6 1/2°, patterns are obtained from very small samples.--D. O. Emerson.

3-3058. Cameron, Eugene N., and others. ROTATION PROPERTIES OF CERTAIN ANISOTROPIC ORE MINERALS: Econ. Geology, v. 56, no. 3, p. 569-583, 2 figs., table, May 1961, 11 refs.

Rotation properties of 82 anisotropic ore minerals in various wavelengths of light have been measured. Values of the rotation angles for the various minerals range from sensibly 0° to 23.2°. Phase differences (2θ) range from negligible to more than 26.3°. The phase differences of most of the minerals are positive. The minerals studied show a variety of patterns of dispersion of both A_r and 2θ.

The study indicates that the range of values of rotation properties of ore minerals is sufficiently broad to make these properties useful in identifying minerals with the microscope, particularly when the properties are used in conjunction with other optical properties.--Auth.

3-3059. Terada, K., and F. William Cagle, Jr. THE CRYSTAL STRUCTURE OF POTARITE (PdHg) WITH SOME COMMENTS ON ALLOPALLADIUM: Am. Mineralogist, v. 45, no. 9/10, p. 1093-1097, 2 tables, Sept. - Oct. 1960, 12 refs.

X-ray powder patterns of synthetic potarite are reindexed for a body-centered tetragonal cell a₀ = 3.0205 Å, c₀ = 3.7067 Å, with cell content PdHg. The structure is the AuCu type L1₀ with space group P 4/mmm and probably the Hg at 0,0,0, and Pd at 1/2,1/2,1/2. The broad diffraction lines of natural potarite can be sharpened by recrystallizing the sample at only 100°C. for 6 hours. Allopalladium is not a simple Pd amalgam because it has not been found in the PdHg system in the range Pd to PdHg₇.--D. O. Emerson.

3-3060. Kosevich, V. M. DETECTION OF DISLOCATION DEFECTS IN ANTIMONY BY THE ETCH METHOD: Kristallografiya, in translation, v. 5, no. 5, p. 715-721, 8 figs., March-Apr. 1961, 9 refs.

Single crystals of Sb have already been etched, using the etchant CP-4 having the following composition: HF - 3 parts, HNO₃ - 5 parts, CH₃COOH - 3 parts, Br₂ - 1 part. Faced etch pits were obtained on the (111) plane, block boundaries were detected, and it was found that the dislocation density varied during deformation, but the authors do not reproduce any etch patterns on twin lamellae. The dislocation defects produced in direct and reverse twinning have been studied.--Auth., p. 715.

3-3061. Klassen-Neklyudova, M. V., and A. A. Urosovskaya. DEFORMATION OF ROCK SALT CRYSTALS AT ELEVATED TEMPERATURE: Kristallografiya, in translation, v. 5, no. 5, p. 709-714, 5 figs., March-Apr. 1961, 11 refs.

NaCl crystals were compressed rapidly at 500-600°C. or were deformed at 20°C. and then subjected to long-continued heating. It is shown that in both cases the reoriented regions are recrystallization grains. In the first case, the rate of growth of a grain is approximately 200 times greater than in the second case. The supposition that mechanical twinning of NaCl crystals at high temperatures is possible according to the spinel law was not confirmed.--Auth.

3-3062. Grigorev, D. P. THREE TYPES OF PLASTIC DEFORMATION IN GALENA. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 3, no. 7, p. 586-597, 13 figs., July 1961, 32 refs.

The aim of the article is to give a characteristic of plastic deformations of galena in nature. Under the action of pressure galena deforms plastically by gliding, mechanical twinning, and polygonisation. Each deformation process is examined on the basis of a dislocational mechanism, taking into consideration observations in nature and data of experiments.--Auth. English summ.

3-3063. Golding, H. G., and others. DEHYDRATION AND REHYDRATION OF FERRIMOLYBDITE FROM LOWTHER, NEW SOUTH WALES: Am. Mineralogist, v. 45, no. 9/10, p. 1111-1113, illus., table, Sept. - Oct. 1960, 2 refs.

Well crystallized ferrimolybdate was fully hydrated when collected, and X-ray diffraction patterns showed that it suffered no perceptible change during dry summer storage. Dehydration with progressive collapse of the crystal structure did occur when it was heated between 50 and 100°C. or desiccated over H₂SO₄. The collapse appears to take place in definite stages. Partially dehydrated material can be fully rehydrated.--D. O. Emerson.

3-3064. Startsev, V. I., and others. THE FORMATION OF DISLOCATIONS IN THE TWINNING OF CALCITE: Kristallografiya, in translation, v. 5, p. 703-708, 4 figs., March-Apr. 1961, 12 refs.

This paper deals with the twinning process in calcite crystals, studied by the method of selective etching. It is shown that the observed phenomena experimentally confirm certain hypotheses of the dislocation theory and can be explained within its framework. --Auth.

3-3065. Clark, Joan R. X-RAY CRYSTALLOGRAPHY OF LARDERELLITE, $\text{NH}_4\text{B}_5\text{O}_6(\text{OH})_4$: Am. Mineralogist, v. 45, no. 9/10, p. 1087-1093, 4 tables, Sept.-Oct. 1960, 6 refs.

Single crystal X-ray studies of larderellite from Larderello, Italy, together with the observed density of 1.905 ± 0.004 g. cm^{-3} yield a chemical formula of $(\text{NH}_4)_2\text{B}_{10}\text{O}_{16} \cdot 4\text{H}_2\text{O}$ and a structural formula of $\text{NH}_4\text{B}_5\text{O}_6(\text{OH})_4$. Among G. Marinelli's observed spacings of impure larderellite are faint lines which indicate the natural occurrence of $\text{KB}_5\text{O}_6(\text{OH})_4 \cdot 2\text{H}_2\text{O}$. --D. O. Emerson.

3-3066. Rumanova, I. M., and M. N. Znamenskaya. THE CRYSTAL STRUCTURE [sic] OF ANAPAITE: Kristallografiya, in translation, v. 5, no. 5, p. 650-658, 3 figs., 5 tables, March-Apr. 1961.

The structure of anapaite $\text{Ca}_2\text{Fe}(\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}$ has been completely determined from ordinary and modulated projections of the Patterson function onto the xy plane. The structure is basically composed of layers of oxygenous Fe octahedra and Ca heptaver-tica which are parallel to (010) and joined by PO_4 tetrahedra. The cell parameters of anapaite obtained are: $a = 6.39\text{\AA}$, $b = 6.86\text{\AA}$, $c = 5.89\text{\AA}$, $\alpha = 101^\circ$, $\beta = 104^\circ$, $\gamma = 71^\circ$. --Auth.

3-3067. Dellwig, Louis F., and Walter E. Hill, Jr. VARIATIONS IN INTERFERENCE FIGURES IN SINGLE CRYSTALS OF ZONED SMOKY QUARTZ: Am. Mineralogist, v. 45, no. 9/10, p. 1116-1119, illus., Sept.-Oct. 1960, 5 refs.

Colored growth bands of smoky quartz crystals from radioactive veins of the Wet Mountain Th belt, Custer and Fremont counties, Colorado, generally have a larger $2V$ (8°) and more Na, V, and Al than the colorless bands ($2V = 0^\circ$ - 2°). The coloration is probably due to radioactive exposure, and the structural change is due to the orderly substitution of one element for another. --D. O. Emerson.

3-3068. Lazko, E. M. REMARKS ON THE GENETIC SIGNIFICANCE OF CERTAIN TYPES OF HARD MINERAL INCLUSIONS IN QUARTZ. Translated by Royer and Roger, Inc.: Internat. Geology Rev., v. 3, no. 6, p. 474-481, 10 illus., June 1961, 14 refs.

Syngenetic and protogenetic hard mineral inclusions are met with in crystals of quartz. Syngenetic inclusions are of special interest for the determination of some important details in the mechanism of crystal growth and the elucidation of the composition and concentration of quartz-forming solutions. Protogenetic inclusions facilitate the forming of conclusions on the regime of solutions, the conditions of growth of crystals, etc. For instance, a study of the "hair-stone" (crystals of quartz with numerous accumulations of fine needles of tourmaline, rutile, etc.)

suggest that rock crystals often grow in open cavities in very tranquil conditions, probably, mainly as a result of a diffusion of the substance. The presence of "intercrystal druses" of quartz in quartz may witness a pulsating intake of solutions and the absence of an equilibrium in the latter. The study of some inclusions suggests a possible formation of crystals of rock crystal resulting from a recrystallization of the enclosing rocks (quartzites). So-called powderings which have repeatedly been described and which are widespread in nature, evidently originate in consequence of various processes and can belong to the group of syngenetic inclusions. --Auth. English Summ.

3-3069. Lewis, J. F. THE OCCURRENCE OF ORTHOPYROXENE WITH LOW OPTIC AXIAL ANGLE: Am. Mineralogist, v. 45, no. 9/10, p. 1125-1126, Sept.-Oct. 1960, 3 refs.

Orthopyroxene from dacities of the Tauhara Volcano, North Island, New Zealand, has a minimum $2V_x$ of 35° , 10° below previously reported minimums. Although orthopyroxene from the marginal unoxidized rocks is normal ($2V_x = 72^\circ$ - 54° , $\text{av.} = 67^\circ$, $Y = 1.697$ - 1.720) that from the oxidized rocks of the core is unusual ($2V_x = 70$ - 35° , $\text{av.} = 60^\circ$, $Y = 1.700$ - 1.736). The few crystals with $2V_x$ below 45° have a rim of opacite and are discrete grains or inclusions in plagioclase. The unusual optical properties are probably due to oxidation and heating rather than primary compositional differences. --D. O. Emerson.

3-3070. Chase, A. B., and Robert A. Lefever. BIREFRINGENCE OF SYNTHETIC GARNETS: Am. Mineralogist, v. 45, no. 9/10, p. 1126-1129, Sept.-Oct. 1960, 3 refs.

Crystals of synthetic garnet, $\text{R}_3\text{Ga}_5\text{O}_{12}$ and $\text{R}_3\text{Al}_5\text{O}_{12}$ (where R is Y, Yb, or Tm), exhibit birefringence up to 0.002 both as halos around larger inclusions and as well defined growth related bands. The birefringence was less in the vicinity of voids and decreased sharply on annealing at 1,200 C. Asterism of Laue spots from back reflection X-ray photographs adds to the belief that the birefringence is due to strain. Preliminary work on natural garnets suggests that strain and not twinning is the primary source of their birefringence. --D. O. Emerson.

3-3071. Klevtsova, R. F., and N. V. Belov. CRYSTAL STRUCTURE OF SPURRITE: Kristallografiya, in translation, v. 5, no. 5, p. 659-667, 2 figs., March-Apr. 1961, 20 refs.

Additional X-ray data allows refinement of previous crystal structure determinations of spurrite. The structure of spurrite $\text{Ca}_5(\text{SiO}_4)_2\text{CO}_3$ can be roughly described as consisting of double layers of $\alpha\text{-Ca}_2\text{SiO}_4$ of olivine structure, between single layers of CaCO_3 with the aragonite structure. The twinning mechanism as well as cation-anion distances are discussed. --E. G. Ehlers.

3-3072. Borshchevsky, Yu. A. ON THE NATURE OF CARBURAN: Geokhimiya, in translation, 1959, no. 6, p. 679-682, 3 figs., pub. 1961, 13 refs.

Carburan is found to be a radioactive vein bitumen, being a mixture of uraninite (pitchblende) and hydrocarbon, and to form metasomatically in the hydrothermal stage of a pegmatite process.

The most probable source of carburan C is the including graphite gneisses, i.e., the C is of organic origin and hydrothermal by its genesis.

For the above mentioned group of substances having been formed in this way the name "carburan" is proposed.--Auth.

3-3073. Mandarino, Joseph A., and Scott J. Williams. FIVE NEW MINERALS FROM MOCTEZUMA, SONORA, MEXICO: Science, v. 133, no. 3469, p. 2017, June 23, 1961, 2 refs.

Five new minerals have been found in a Te deposit near the town of Moctezuma, Sonora, Mexico. Preliminary study shows that they are a lead-oxy-fluoride, a zinc tellurite or tellurate, a manganese-zinc tellurite or tellurate, a manganese tellurite or tellurate, and an iron tellurite or tellurate.--Auth.

3-3074. Williams, K. L. A NATURAL OCCURRENCE OF NICKEL HYDROXIDE: Am. Mineralogist, v. 45, no. 9/10, p. 1109-1110, table, Sept.-Oct. 1960, 2 refs.

Small amounts of a pale greenish-blue earthy mineral occur with zaratite and hellyerite or serpentinite from the Lord Brassey mine, Heazlewood, Tasmania. Although some lines are diffuse, its diffraction pattern matches that of synthetic nickel hydroxide. The refractive index (about 1.68) is close to the 1.69 value of the synthetic material. Although there is no doubt about the identity of this mineral, no name will be suggested until more of the material is obtained and adequately analyzed.--D. O. Emerson.

3-3075. Dietrich, Richard V. CALCIOSTRONTIANITE FROM PULASKI AND ROCKINGHAM COUNTIES, VIRGINIA: Am. Mineralogist, v. 45, no. 9/10, p. 1119-1124, 2 figs. incl. illus., table, Sept.-Oct. 1960, 5 refs.

X-ray, optical, chemical, thermal, physical and paragenetic data are given for strontianite with about 8% CaO (calciostrontianite) from calcite-lined vugs near Dublin, Pulaski County, and Harrisonburg, Rockingham County, Virginia.--D. O. Emerson.

3-3076. Redden, Jack A. CORDIERITE "FOSSILS" IN PITTSYLVANIA COUNTY, VA.: Mineral Industries Jour., v. 8, no. 1, p. 4-5, 2 illus., March 1961.

Porphyroblasts of cordierite in muscovite-rich schist of the James River marble belt, probably the Mount Athos formation (Paleozoic?), on preliminary examination appeared to be organic remains resembling crinoid stems, corals, or Bryozoa. Absence of other varieties of organisms, specimens which transect the bedding, and the finding of cores of chlorite indicate the nonorganic origin of these replacement structures.--M. Russell.

3-3077. Newton, Joseph. CLAY, ITS COMPOSITION, PROPERTIES AND USES: Idaho, Bur. Mines & Geology, Inf. Circ. 5, 35 p., 3 illus., 1960, 7 refs.

The paper begins with a discussion of the origin and basic crystalline structure of the clay minerals. Approximately one-half of the paper deals with the crystal structure of clay minerals and the relation of this structure to the properties of clay. The remainder of the paper deals briefly with the following: 1) methods of identifying clay minerals; 2) properties and identification of clays (as distinguished from clay minerals); 3) commercial classification of clays; and 4) some characteristics and applications of the major commercial clays.--Auth.

3-3078. Baetcke, Gustav B. IDENTIFICATION GUIDE TO COMMON MINERALS AND ROCKS OF VIRGINIA: Virginia, Div. Mineral Resources, Inf. Circ. 3, 51 p., fold. map, 9 pls., 3 tables, 1961, 16 refs.

A great number of different kinds of minerals and rocks are found in Virginia, and the state is a rich and generous collecting area for "rockhounds" and mineral collectors. This identification guide contains descriptions of minerals and rocks, descriptions of physical tests, and illustrations which may be used to make rock and mineral identifications. General areas are listed from which particular rocks and minerals may be collected. Information about equipment, collecting methods, and specimen preparation is included, and should the collector become interested in obtaining more technical information, a list of selected references appears at the end of the publication.--Auth. introd.

3-3079. Ford, T. H. L. THE PROSPECTOR IN SOUTHERN RHODESIA: Earth Sci., v. 14, no. 1, p. 16-18, illus., Feb. 1961.

This popular article describes the general geologic, topographic, and mineralogic conditions confronting the individual prospector in Southern Rhodesia. Based on past finds, one should seek chromite, asbestos, Sn, Li, beryl, Cu, Ni, Fe, limestone, mica, and corundum. Unusual mineral specimens to be sought include, in addition, quartz geodes, lepidolite greisen with tourmalines, nephrite, garnet, and various Cu minerals.--M. Russell.

3-3080. Fleener, Frank L. OUR FASCINATING, ENIGMATIC GEODES: Earth Sci., v. 14, no. 1, p. 24-26, 3 illus., Feb. 1961.

In a popular style, the physical characteristics, natural occurrence, and theories of origin of geodes are covered. Some of the more common mineral finds in geodes include calcite, galenite, sphalerite, dolomite, pyrite, millerite, and ankerite. Petroleum-filled geodes are found in the vicinity of Niota, Illinois. The Keokuk, Iowa, geode area contains an apparently inexhaustible supply of beautiful large geodes.--M. Russell.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Geochemistry 3-3002, 3-3004, 3-3017, 3-3051; Mineralogy 3-3054, 3-3078.

3-3081. Tilley, C. E. KILAUEA MAGMA 1959-60: Geol. Mag., v. 97, no. 6, p. 494-497, illus., Nov. -

Dec. 1960, 4 refs.

Variants of the 1959-1960 eruptions of Kilauea are compared chemically with the preceding flank eruptions of 1955. The first lavas extruded in the flank

eruption in 1960 are reported to be very similar chemically and mineralogically to the lavas erupted in 1955, but near the end of Jan. the nature of the lava gradually changed, olivine phenocrysts became abundant, and during the last week of strong lava output in Feb. the composition was nearly identical with that of the earlier eruption at Kilauea Iki.--Auth. abs. & concl.

3-3082. Aramaki, Shigeo. CLASSIFICATION OF PYROCLASTIC FLOWS. Translated by Reiko Fusejima: Internat. Geology Rev., v.3, no.6, p. 518-524, fig., table, June 1961, 26 refs.

Pyroclastic flow is defined as the flow of high-temperature, essential, fragmental materials. This is synonymous with the nuée ardente in the broad sense. Three modes of emplacement of high-temperature, essential, solid (or liquid) materials after the ejection from the crater may be recognized: 1) projection of fragments from the crater by explosive expansion of gas within the crater; 2) descent of fragments or liquid magma from the crater caused only by the action of gravity; and 3) swift downflow of the mixture of gas and fragments. This last is intermediate between the first 2 and corresponds to pyroclastic flow.

A new classification of pyroclastic flows is proposed based upon viscosity of the materials, which is inferred from the nature of the deposit. The volume of the deposit increases as the viscosity decreases.

1) Nuée ardente in the strict sense. Represented by the nuée ardente of Mt. Pelee, Merapi, etc. The fragments are less porous, which indicates the high viscosity. The volume of the deposit is small, generally less than 0.01 km.³

2) Pyroclastic flow of the intermediate type. Represented by certain pyroclastic flows of Asama, Hakone, and Muoko volcanoes. Both viscosity and volume (0.1-1 km.³) are intermediate between 1) and 3).

3) Pumice flow. Represented by pumice and tuff flows of all sizes, such as those of Crater Lake, Hakone, Katmai, and Aso volcanoes. Low viscosity leads to full vesiculation into pumice. Many of them are larger in volume (>19 km.³) than 1) and 2), and calderas of the Krakatau type are often formed after the eruption of larger pumice flows.--Auth. English summ.

3-3083. Moore, H.R. APACHE TEARS: Arizona Highways, v. 37, no. 7, p. 8-11, 12 figs., July 1961.

The occurrence of obsidian in perlite lava flows near Superior, Arizona, is briefly described in a popular vein. The perlite is presently being mined as a local source of insulating material. The operator estimates the commercial deposit to be 2 mi. wide by 15 mi. long by up to 100 ft. in thickness. A sideline of the quarrying operation is selling "Apache Tears," i.e. obsidian nodules, to tourists.--F.D. Shelden.

3-3084. Bagdasarov, E.A. ALKALIC PEGMATITES OF THE AFRIKANDA MASSIF. Translated by Roger and Roger, Inc.: Internat. Geology Rev., v. 3, no. 6, p. 463-473, 2 figs., 3 tables, June 1961, 6 refs.

Paragenetic sequences observed in ore-bearing and barren pegmatites associated with alkalic ultramafic rocks are described. The Afrikanda massif is located in the western part of the Kola peninsula U.S.S.R., and is represented by nepheline pyroxenite. In its central part are ore-bearing pegmatites containing concentrations of titanomagnetite, klaprothite, schorlomite garnet, nepheline, pyroxene, and phlogopite. Processes of replacement are described, and a comparison is made of geochemical features of these pegmatites as compared to granitic pegmatites, nepheline syenite pegmatites, and gabbroic pegmatites.--M. Russell.

3-3085. Aleksandrov, I.V. ON THE PECULIARITIES OF EVOLUTION OF THE ROCKS OF THE KRIVOI ROG SERIES RESULTING FROM ALKALI METASOMATISM: Geokhimiya, in translation, 1959, no. 4, p. 451-470, 4 figs., 2 tables, pub. 1960, 4 refs.

The solutions which acted on the metamorphic rocks simultaneously and produced metasomatic changes differed in composition and hence could not have come from a single source such as a magmatic chamber. It is believed that metasomatism was effected by pore solutions present in the metamorphic rocks and that the solutions in the mica schists differed in composition from the solutions in the ferruginous rocks. Metasomatism proceeded with falling temperature during the first stage of retrograde metamorphism. Mica schists were usually changed into albites and chlorite-muscovite-albite schists; the quartz-magnetite-amphibole schists, to magnetite-alkali amphibole schists; and the amphibole-magnetite-quartzites to magnetite-alkali amphibole-aegirine rocks and aegirinites. In the zones of intensive percolation of solutions through the ferruginous quartzites, alkali amphibole-magnetite ores were formed.

Al, Fe, and Mg were inert during alkali metasomatism. Their mobility under usual conditions (excluding the case of mixing of solutions) did not change to any extent. The mobility of Si increased but it remained inert since its concentration in the solutions was determined by the mineralogical composition of the metasomatites (aegirine, alkali amphiboles, albite). Na, K, and carbon dioxide were completely mobile.

Alkali metasomatism in the Krivoy Rog region was characterized by the following features: a) precipitation of Na, b) removal of Si, c) near immobility of Al, Fe, and Mg under ordinary conditions, and d) oxidation of Fe during the formation of aegirine and the alkali amphiboles and, to a smaller degree, during martitization.

This study is not definitive. It contains only those points which it was possible to establish by studying the material cited in the paper.--Auth. summ.

11. GEOHYDROLOGY

See also: Geologic Maps 3-2884; Areal and Regional Geology 3-2896; Engineering Geology 3-3164.

3-3086. Witherspoon, D.F. ELECTRICAL GROUND-WATER PROSPECTING: Agr. Eng., v. 42, no. 3, p. 134-135, 138, March 1961.

As ground-water storage is more intensively used and the search for additional supplies is undertaken, an increased use will be made of geophysical methods of subsurface investigation. One of these which offers the most promise in ground-water prospecting is the electrical resistivity method. By this method

the apparent electrical resistivity variation with depth is determined. Interpretation of the results allows the delineation of layers of different resistivity. This information can be correlated with the water-bearing properties of each layer. Indications may be obtained of particle size, hydraulic conductivity, and salt content of the water in the pores.

The method uses 4 electrodes on the surface of the soil. A known current is applied to 2 electrodes, and the potential drop is measured across the other 2 electrodes. From this information the apparent resistivity is determined.

Wenner was the first in North America to set forth the theory of resistivity determination of the earth. Gish and Rooney further developed the application of the theory with respect to earth currents and their effect on communications. These investigations led to the development of the Wenner configuration of 4 electrodes equally spaced. In Europe the electrical resistivity method developed also toward a 4-electrode configuration in which the potential electrodes are kept at a constant separation while the current electrodes are moved apart. This method was developed by C. Schlumberger, of La Compagnie General de Geophysique.

The measurement of the electrical resistivity of the earth is useful in determining various properties of the subsurface layers. The Schlumberger configuration of electrodes for resistivity measurement has distinct advantages over the Wenner configuration in the field operation. By application of the resistivity method to ground-water prospecting increased knowledge of the subsurface stratum will allow better use to be made of ground-water supplies.

--Courtesy Highway Research Abstracts, v. 31, no. 6, p. 31, June 1961.

3-3087. Demidova, L. S., and others. AN EXPERIMENT ON THE UTILIZATION OF THE GEOBOTANICAL METHOD IN HYDROGEOLOGIC STUDIES OF THE CHERNYYE ZEMLI (BLACK EARTH) REGION. Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3, no. 6, p. 495-500, 4 figs., June 1961, 2 refs.

The authors consider those geobotanical indicators which differentiate ground-water resources of varying salinity and depth. The territory under study is the Chernyye Zemli region; the aim is primarily to locate potable water for cattle. The most reliable fresh-water indicators were found to be certain sweet clover associations. The lower the mineral content of the water and the closer it is to the surface, the more luxuriant these plant species. Species of sagebrush are another reliable sign. Moderately saline waters were marked by associations of wormwood with some dwarfed sagebrush and cyresses or with vetch, *Gypsophila*, and wild rye. It is noted that the latter are indicators of moderately saline water when found in association with wormwood. Saline waters (dry residue over 12 g. per l.) were characterized by various sagebrushes, particularly *Artemisia incana*, and if this species is present in sweet clover associations even in small numbers, a higher degree of salinity is present. Field checking verified 78% of interpretations from aerial photographs.--A. Eustus.

3-3088. Vostokova, E. A. APPLICATION OF THE GEOBOTANICAL METHOD IN HYDROGEOLOGIC STUDIES OF DESERTS AND SEMIARID REGIONS. Translated by Gaida M. Hughes: Internat. Geology

Rev., v. 3, no. 6, p. 485-494, 6 figs., 2 tables, June 1961, 8 refs.

Plant associations in arid and semiarid regions serve as indicators not only of presence of ground water, but of its depth, relative salinity, and seasonal variations. Plants such as phreatophytes may serve as direct water indicators, while *Anabasis salsa*, an indirect water indicator, is more indicative of geologic conditions, in this case clayey or argillaceous soils. An *Anabasis salsa* association in the Temirsk-Aktyubinska Ural region indicates that the ground water is located at considerable depth; in the northwestern Caspian area, however, this same association is often found in low wastelands forming localized impermeable horizons where ground water may be found at depths of 5 to 10 m. Some associations indicate the degree of salinity, rather than ground-water depth. Preparation of a ground-water resources map from such geobotanical data requires field work, during which associations around known wells, ponds, or ground-water areas are analyzed to provide criteria for the area as a whole. It has been found that data from field studies tally closely with that made from aerial photographs. Hence, after initial studies are made, prospecting of a given region may be carried out by aerial photographs. Variations in vegetation relative to depth and mineralization of ground water also may be used to forecast changes in the vegetation which would occur following construction of an irrigation system.--A. Eustus.

3-3089. Hem, John D. CALCULATION AND USE OF ION ACTIVITY: U.S. Geol. Survey, Water-Supply Paper 1535-C, 17 p., 2 figs., pl. (in pocket), 3 tables, 1961, 14 refs.

A nomograph and a set of curves can be used to simplify the computation of activity from the measured concentration for constituents of natural water containing as much as 5,800 parts per million of dissolved solids. These devices are applied in mass-action computations of undissociated dissolved carbon dioxide and computations of saturation status with respect to calcite in 16 samples of natural water whose dissolved solids content ranges from 91 to 4,170 p.p.m. When activity values are used to compute undissociated dissolved carbon dioxide, the value obtained is 5 to 25% less than when the computation is made without activity corrections. Computed saturation pH with respect to calcite is from 0.1 to 0.6 of a pH unit greater when activity corrections are made than when they are not.

Activity corrections are also used in computing redox potentials from dissolved Fe and pH in natural water, but corrections are no more than 0.02 or 0.03 volt where ionic strength is 0.10 or less.--Auth.

3-3090. Back, William. CALCIUM CARBONATE SATURATION IN GROUND WATER, FROM ROUTINE ANALYSES: U.S. Geol. Survey, Water-Supply Paper 1535-D, 14 p., 3 figs., pl., 1961.

A method, based on thermodynamic principles, of calculating the degree of equilibrium attained between ground water and calcium carbonate is demonstrated by the study of routine chemical analyses of 25 ground-water samples from limestone terranes.--U.S. Geol. Survey.

3-3091. James, Laurence B., and others. SEA-WATER INTRUSION IN CALIFORNIA: California,

Dept. Water Resources, Bull. no. 63, 91 p., 31 pls., Nov. 1958 (not seen at AGI).

This report summarizes for the first time a considerable body of knowledge relating to the problem of sea-water intrusion in California. Some of the major coastal problem areas studied and conclusions reached include the following:

1) Geologic studies indicate 262 coastal ground-water basins contain water-bearing Quaternary and late Tertiary deposits which may be in direct contact with sea water or brackish tidal waters.

2) Detailed studies indicate there is definite evidence of sea-water intrusion in 9 coastal ground-water basins. Five of these basins are in northern and central California and 4 basins are in southern California.

3) There are 71 coastal ground-water basins in which chloride content in ground waters in the coastal portion exceeds 100 parts per million. Source of degradation in these basins is not definitely established, however, sea-water intrusion is suspected in some areas.

4) There are 48 coastal ground-water basins in which there is some development of ground water, but no evidence of any type of ground-water degradation.

5) There are 134 coastal ground-water basins in which there is little or no development of ground water and little or no information regarding geologic, hydrologic, and water-quality conditions.

6) Five methods of control of sea-water intrusion are discussed with respect to design criteria, cost estimates, and use in relationship to geologic and hydrologic conditions in various ground-water basins presently being degraded by sea-water intrusion. Methods include: a) raising of ground-water levels to or above sea level by reduction in extractions and/or rearrangement of areal pattern of pumping draft; b) direct recharge of overdrawn aquifers to maintain ground-water levels at or above sea level; c) maintenance of a fresh-water ridge above sea level along the coast; d) construction of artificial subsurface barriers; and e) development of a pumping trough adjacent to the coast.

7) Significant experimental studies are summarized covering the following fields: a) parameters governing intrusion of saline water; b) recharge of ground water through injection wells; c) recharge of ground water through surface spreading; and d) construction of artificial subsurface barriers through grouting and establishment of earthen walls.

8) Economic and legal considerations of sea-water intrusion. --R. C. Richter.

3-3092. van der Goot, H. A., and others. REPORT BY LOS ANGELES COUNTY FLOOD CONTROL DISTRICT ON INVESTIGATIONAL WORK FOR PREVENTION AND CONTROL OF SEA-WATER INTRUSION, WEST COAST BASIN EXPERIMENTAL PROJECT, LOS ANGELES COUNTY: California, Dept. Water Resources, Bull. no. 63, Appendix B, 55 p., 9 illus., 34 pls., March 1957 (not seen at AGI).

This report presents results of a cooperative investigation by the California Dept. of Water Resources and the Los Angeles County Flood Control District to repel sea-water intrusion into a coastal fresh-water aquifer at Manhattan Beach, Los Angeles County, southern California. The project was designed to obtain experimental data and to determine the feasibility of control of sea-water intrusion by the creation and maintenance of a pressure ridge in a confined coastal aquifer by injection of fresh water through wells.

Nine 12-in. diameter cable tool drilled recharge

wells on 500-ft. centers were installed approximately 2,000 ft. inland from the Pacific Ocean coast line at Manhattan Beach. The recharge wells and 54 observation wells penetrated the confined merged Silverado water-bearing zone of Pleistocene age which was highly degraded in the area due to intrusion of sea water. Metropolitan Water District water used for injection was filtered and partially softened by the zeolite process.

Significant findings of the investigational work include: 1) The project established that prevention and control of sea-water intrusion could be accomplished at the test site by recharge through wells with treated fresh water. 2) A pressure mound, 9 to 14 ft. in height, was established at the site with a recharge rate of approximately 5 c. f. s. per mi. and a well spacing of approximately 500 ft. 3) Recharge rates in wells as constructed at the site ranged from over 1 c. f. s. in gravel-packed wells to 0.5 c. f. s. in non-gravel-packed wells with attendant heads 27-50 ft. within the well casings. 4) Approximately 10 to 15% of the total water injected moves seaward from the injection line. 5) A mass of saline water was pushed inland due to recharging at the test site, with the injected fresh water tending to override the saline wedge. The rate of advance of the saline water was approximately 2,200 ft. in an 18-month period. 6) Utilizing treated Metropolitan Water District Water, a 5-10 p. p. m. chlorination rate was required at the test site to maintain desirable well acceptance rates. --R. C. Richter.

3-3093. Brooks, Norman H. REVIEW OF FORMULAS AND DERIVATIONS FOR THE EQUILIBRIUM RATE OF SEAWARD FLOW IN A COASTAL AQUIFER WITH SEA-WATER INTRUSION: California, Dept. Water Resources, Bull. no. 63, Appendix C, Pt. III, 13 p., 4 figs., Apr. 1960 (not seen at AGI).

This study by Norman Brooks, Consulting Engineer, was a cooperative investigation with the California Dept. of Water Resources on the problem of sea-water intrusion in Manhattan Beach area, West Coast basin, Los Angeles County, California.

Sea water intrudes a confined coastal fresh water-bearing aquifer as a wedge. Because sea water is slightly denser than fresh water, it will tend to underide the fresh water. The shape of the wedge and the distance which it intrudes into the aquifer is controlled in large part by the quantity of seaward flow of fresh water.

A basic formula derived by sea-water intrusion studies at the University of California, Berkeley, for the determination of the seaward rate of flow of fresh water is presented below and was reviewed and checked by 3 methods of solution: 1) application of basic parabola; 2) Muskat's approximate potential theory; and 3) Dupuit-Forchheimer theory.

$$q = \frac{K(S-1)M^2}{2L}$$

q = seaward rate of flow of fresh water, per unit of width; L = length of intruded sea water wedge; M = thickness of pressure aquifer (assumed constant); S = W_s/W = ratio of unit weight of sea water to fresh water; K = coefficient of permeability of aquifer (assumed constant). --R. C. Richter.

3-3094. Bush, A. F., and others. AN INVESTIGATION OF SOME PROBLEMS IN PREVENTING SEA-WATER INTRUSION BY CREATING A FRESH-WATER BARRIER: California, Dept. Water Resources, Bull.

no. 63, Appendix D, 82 p., 18 figs., 20 tables, Apr. 1960 (not seen at AGI).

This study by the Dept. of Engineering, University of California at Los Angeles, was a cooperative investigation with the California Dept. of Water Resources on the problem of sea-water intrusion in the Manhattan Beach area, West Coast basin, Los Angeles County, California.

The establishment of an artificial hydraulic barrier to prevent sea-water intrusion is dependent upon maintaining a continuous flow into the wells along the saline front. This laboratory study on cores from the Silverado water-bearing zone was initiated to determine long-range effect on formation permeability by treatment of injected Metropolitan Water District water by chlorination, acidification, chlorination plus acidification, and filtration plus deaeration.

With the exception of the acid plus chlorine treatment, there was an average reduction in core sample permeabilities of around 40% of the initial value in about 50 hours. Further reductions continued thereafter, the average values at 1,200 hours being 4% for core samples percolated with regular Metropolitan Water District water and 15 to 20% for the samples percolated with chlorine and acid-treated waters. The filtered deaerated samples dropped to less than 1% in 1,000 hours. Reversing the flow had the effect of temporarily restoring a portion of the lost permeability. A combination acid plus chlorine treatment showed the most promise in maintaining a high permeability. The resulting water is corrosive to Fe and steel which may cause operating difficulties if used over extended periods of time.--R. C. Richter.

3-3095. Brennan, Robert. PRELIMINARY CHEMICAL-QUALITY STUDY IN THE MANHATTAN BEACH AREA, CALIFORNIA: California, Dept. Water Resources, Bull. no. 63, Appendix E, 34 p., 7 figs., 5 tables, Apr. 1960 (not seen at AGI).

This study by the U.S. Geological Survey was a cooperative investigation with the California Dept. of Water Resources, on the problem of sea-water intrusion in the coastal segment of a fresh-water bearing aquifer in Coastal segment basin, Los Angeles County, California.

Chemical quality data from the Manhattan Beach area in late 1938 indicates that native ground water in the Silverado water-bearing zone of Pleistocene age was calcium and/or magnesium bicarbonate in type. Study of successive ground-water samples during the period 1938-1953 indicate the bicarbonate-type water originally present has progressively changed to a chloride-type water due to degradation by saline sea water.

Comparison of degraded water with hypothetical mixtures of sea water and native water, and studies of leached core samples from the Silverado zone indicate that simple mixture has not taken place, but that the Na ions in sea water have been exchanged for the Ca and Mg in the sediments. The Ca and Mg percentages are higher and the Na percentage is lower than would be expected from simple mixture.

Chemical quality data from wells normal to the coast show that degradation increases with depth in a landward direction thus substantiating model studies and large experimental field studies that sea water enters a confined water-bearing aquifer as an advancing wedge.--R. C. Richter.

3-3096. Hill, V. G., and A. C. Ellington. CHEMICAL CHARACTERISTICS OF THE GROUND WATER

RESOURCES OF JAMAICA, W. I. 1. A CONTRIBUTION TO THE INTERPRETATION OF HYDROCHEMICAL DATA: Econ. Geology, v. 56, no. 3, p. 533-541, 3 figs., table, May 1961, 11 refs.

Frequency distribution methods are used to show that the ground water of the Clarendon Plains is not homogeneous and can be divided into 3 principal zones - the northern limestone belt, the central trough, and the coastal sand belt. The central trough type water can be further subdivided into sand and limestone types demonstrating the influence of lithology on the water. The specific conductivity, Na and chloride values, are parameters used to determine the frequency distributions.--Auth.

3-3097. Brandon, L. V. PRELIMINARY REPORT ON HYDROGEOLOGY, OTTAWA-HULL AREA, ONTARIO AND QUEBEC: Canada, Geol. Survey, Paper 60-23, 17 p., 4 figs. (1 in pocket), Map 31-1960 (in pocket), scale 1:63,360, 4 tables, 1961, 13 refs.

A compilation of data on the ground-water potential of an area bounded by 45°15'-45°30'N. and 75°30'-76°W., comprising about 400 sq. mi. The report is divided into 2 parts. Pt. 1 is a short description of geology and water-well potential of the area. Archean crystalline limestone; Ordovician limestone, shale, dolomite, and sandstone; and Pleistocene peat, sands, clay and glacial deposits compose the stratigraphic sequence. Sufficient water has always been reported from wells drilled in crystalline rocks, sandstone, dolomite, and shales. Where sand and gravel underlie clay areas there is an abundant supply of water. Pt. 2 is a preliminary technical report on the hydrology of the area, and rocks of each era are studied separately. Aquifer test results are given and discussed; it appears that more wells could be drilled in the area without excessive drawdown, provided the spacing is adequate. Chemical analyses detected mineralized and saline conditions in deep wells. Insufficient data are available to outline the ground-water drainage basins or to estimate recharge, but there is no evidence of a significant change in ground-water levels in the past 10 years.--M. Stewart.

3-3098. California, Dept. of Water Resources. QUALITY OF GROUND WATERS IN CALIFORNIA, 1958: Its: Bull. no. 66-58, 69 p., 7 maps, tables, Nov. 1960.

While degradation of the quality of ground water from such sources as industrial and urban wastes and use and reuse of waters for irrigation has continued to increase, the major threat to ground-water quality in California in 1958 was sea-water intrusion. In many of the state's coastal basins, where the draft on ground water has exceeded the safe yield, ground water levels have been so lowered as to permit landward encroachment of salt water. Among the areas showing such degradation are: Santa Clara Valley; Pajaro Valley; Salinas Valley; Oxnard Plain basin; West Coast basin; East Coastal Plain; San Luis Rey Valley, Mission basin; and Tia Juana Valley basin. In other basins, both coastal and inland, significant increases or decreases in mineral concentration in individual wells were noted. These changes, however, appear to be local in extent and do not necessarily indicate basin-wide water quality trends. Except in coastal areas subject to intrusion, or in individual wells situated near specific sources of degradation, ground water quality did not change significantly from that found in 1957.--Auth.

3-3099. Horn, William L., and others. INVESTIGATION OF UPPER FEATHER RIVER BASIN DEVELOPMENT: California, Dept. Water Resources, Bull. no. 59-2, 265 p., 8 illus., figs., 19 pls., 59 tables, Oct. 1960.

This report contains an inventory of the surface- and ground-water resources of the Upper Feather River drainage area in Plumas County, northern California, and presents a basin-wide master plan for multi-purpose water development for all beneficial uses.

Ground-water storage in the drainage basin occurs in 12 small mountain valleys. Water-bearing deposits include: unconsolidated gravel, sand, silt, and clay associated with alluvial fans; flood-plain deposits; stream-channel deposits; stream-terrace deposits; lake-bed sediments; and occasional sand dune, glacial, and lake-terrace deposits. Fractured and jointed volcanic flow rocks locally may be moderately to highly permeable.

Ground-water basins with adequate storage capacity and sufficient permeability to justify development for irrigation exist in Sierra, Indian, and American valleys. In Sierra Valley, ground water is confined under extensive, thick lake-bed sediments, and water flows from many deep wells under pressure. Deep aquifers are thin and yield hot, mineralized water in local areas. In American and Indian valleys, sufficient ground-water capacity exists to take care of most future water needs, even though well logs in Indian Valley indicate materials with low permeability and specific yield.

Physical characteristics of water-bearing deposits, and occurrence and quality of ground water are not known in Mohawk, Mountain Meadows, Meadow, Lake Almanor, Grizzly, Clover, Little Last Chance, Squaw, and Genesee valleys due to lack of well logs, water-level measurements and water quality data.--R. C. Richter.

3-3100. Callahan, Joseph T. GROUND WATER FOR GEORGIA'S EXPANDING ECONOMY: Georgia Mineral Newsletter, v. 13, no. 4, p. 152-160, 6 maps, graphs, Winter 1960.

This report summarizes the program of ground-water investigations from 1938 to 1960 and points out the need for the continuation of these studies to provide information about water resources that will be inducement to new industries and help cities in water-supply development. The illustrations show graphically the population changes in the state, the ground-water provinces and problem areas, the funds expended, and the areas covered by reports. A list of reports on ground water is included.

The industrialization of some areas has created great demands for ground water. Irrigation practices probably will increase the demand. Georgia has abundant water resources, but their extent is not yet completely known. A knowledge of the amount of ground water available will provide data for the management of this important resource.--Auth.

3-3101. Wait, Robert L. SUMMARY OF THE GROUND-WATER RESOURCES OF TERRELL COUNTY, GEORGIA: Georgia Mineral Newsletter, v. 13, no. 3, p. 117-122, 2 maps, 3 tables, Fall 1960, 6 refs.

Most of the use of the ground water of Terrell County is municipal and domestic. There are numerous aquifers in which artesian conditions exist,

especially in the Ocala, Lisbon, Tallahatta, and Clayton formations of Tertiary age. Production from the Clayton averages about 130 g.p.m. for 6" holes and near 800 for 20" holes. Chemical analyses of the water from 4 producers out of the Clayton formation are given.--J.G. Lester.

3-3102. Siple, George E. PIEZOMETRIC LEVELS IN THE CRETACEOUS SAND AQUIFER OF THE SAVANNAH RIVER BASIN: Georgia Mineral Newsletter, v. 13, no. 4, p. 163-166, map, Winter 1960, 3 refs.

A piezometric study of the principal sand aquifer of late Cretaceous age. The hydrostatic head of water varies from 380 ft. near Aiken, South Carolina, and 220 near Augusta, Georgia, to about 120 ft. at the coast line.--J.G. Lester.

3-3103. Leonard, Alvin R., and Delmar W. Berry. GEOLOGY AND GROUND-WATER RESOURCES OF SOUTHERN ELLIS COUNTY AND PARTS OF TREGO AND RUSH COUNTIES, KANSAS: Kansas, State Geol. Survey, Bull. 149, 156 p., 20 figs., 9 pls. incl. 2 maps and secs. (in pocket), 11 tables, 1961, 65 refs.

This report describes the geography, geology, and ground-water resources of an area about 4 to 13 mi. wide and 37 mi. long, containing approximately 365 sq. mi. The climate is subhumid, the mean annual precipitation is 22.90 in. and the mean annual temperature is 54.7°F. Minerals produced in the area are oil, limestone, sand and gravel, silt and clay, and volcanic ash.

The exposed rocks range in age from Late Cretaceous to Recent. The Pleistocene alluvial deposits, which range in age from Nebraskan to Recent, are the principal aquifers in the area. The Dakota formation (Cretaceous) supplies water for rural domestic and stock use in parts of the area. The shape and slope of the water table are illustrated by a map showing contours of the water table and depth to the water table in wells. Ground water in the Pleistocene alluvial deposits moves downstream and toward the principal streams. Ground water is recharged mainly from local precipitation; ground water is discharged chiefly by seepage into streams and by transpiration by plants.

In most of the area the ground water is suitable for domestic, stock, and municipal use. The water ranges from soft to hard and from moderately to strongly mineralized. Water in the Dakota formation generally is of the sodium chloride type, has a large amount of dissolved solids, and is moderately hard. Most water from the Pleistocene deposits is of the calcium bicarbonate type and contains moderate to large amounts of dissolved solids. Water from most of the aquifers in the area is rated good to permissible for irrigation.

The hydrologic and geologic field data upon which this report is based include records of 141 wells, chemical analyses of water from 49 domestic and stock wells and from 5 municipal supplies, and logs of 50 test holes, 1 oil well, and 80 jetted test holes.--Auth.

3-3104. Lang, Joseph W., and Ernest H. Boswell. PUBLIC AND INDUSTRIAL WATER SUPPLIES IN A PART OF NORTHERN MISSISSIPPI: Mississippi, State Geol. Survey, Bull. 90, 9 figs., pl., 5 tables, 1960, 21 refs.

Ground water furnishes the public and industrial supplies for all the communities except Columbus in

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the 28 counties in northern Mississippi constituting the region of this report. Approximately 210,000 people are supplied by the 66 municipal water systems and the wells of smaller communities, 2 universities, and several Government installations. The total average daily pumpage for public use is about 21 1/2 million gallons, of which an average of about 2 1/2 m. g. d. (million gallons a day) is pumped by Columbus from Luxapalila Creek. Industrial pumpage from wells (12 m. g. d.) is equivalent to more than half the total public pumpage. The increasing use of water during the past 15 years has been accelerated since 1955 as a result of the growing industrial economy, and future water needs promise to increase year by year.

The region lies on the E. flank of the Mississippi embayment of the Gulf Coastal Plain and is underlain for the most part by marine and continental sediments ranging in age from Cretaceous to Recent. Paleozoic rocks crop out in a narrow band in the northeastern part of the state and form the bottom of the large downwarped and faulted trough of the embayment to the W. Cretaceous and younger sediments of sand, gravel, clay, lignite, chalk, and limestone, which reach a total thickness of 3,000 ft. or more, occupy the trough. Major rock divisions crop out in bands of varying width across the surface, and the formations dip westward from their outcrops at an average rate of about 25 ft. to the mi. most of them thickening and increasing in dip in the direction of the embayment.

Aquifers in the hard rocks of Paleozoic age have been developed very little in northeastern Mississippi except for domestic and farm supplies, mostly on or near the outcrop in Tishomingo County. They remain potentially an important source of small to moderately large water supplies in several places in the extreme northeastern part of the region. Electric logs of borings for oil indicate that the Lower Cretaceous series may contain substantial unused aquifers beneath an area extending from northern Noxubee County northwestward across parts of Lowndes, Okitibbeha, and Clay counties.

Sand and gravel of the Tuscaloosa group and sand of the Eutaw formation, of Late Cretaceous age, store vast quantities of fresh water within the Tombigbee River basin and adjacent areas on the N. and W. and are the principal sources of water supply in these areas. In the lowlands of the Tombigbee, these rocks yield artesian flows ranging from a few gallons per minute to more than 500 g. p. m. to wells 200 to 1,800 ft. deep. The water is soft and of low moderate mineralization. At Macon, the sands of the Coker formation yield large supplies of soft water for municipal and industrial uses; when drilled

in 1954 one well had a flow of 250 g. p. m. Many small-diameter wells have been flowing continuously for many years in the lowlands of the Tombigbee River basin. The Coffee sand of the Selma group yields small to moderate supplies to many drilled domestic and farm wells and a few industrial and municipal wells N. of Tupelo to the Tennessee line. The Ripley formation furnishes moderately hard to hard water of low to moderate mineral content to many artesian wells both shallow and deep from southern Chickasaw County northward to the Tennessee line.

Tertiary rocks are the principal source of water supply throughout most of the central and western parts of the report region. Sands of the Wilcox group, the Meridan sand member of the Tallahatta formation, and the Sparta sand are excellent aquifers, each yielding soft water requiring little or no treatment for municipal and industrial supplies. Locally Fe may be a problem. The shallow alluvium, of Quaternary age, is highly productive of hard water of moderate mineral content in the Yazoo delta of Panola and Tallahatchie counties. The nearly constant year-round temperature of the water from the alluvium (about 63° to 64°F.) makes it especially suitable for heat-exchange uses.

The substantial flows in several of the streams in the region, particularly the Tombigbee at Columbus and the Tallahatchie at Batesville, represent a valuable resource that can be developed. Large amounts of water could be made available for water supplies at several other places by the construction of dams and other facilities. The 4 principal surface-water reservoirs in Mississippi are located in the western part of the area; they are Arkabutla reservoir on the Coldwater River, Enid reservoir on the Yocona River, Grenada reservoir on the Yalobusha River, and Sardis reservoir on the Tallahatchie River. Although they were built primarily for flood control, appropriation of water from the reservoirs is subject to approval by the Corps of Engineers, U. S. Army, and the Mississippi Board of Water Commissioners.

Chemical analyses of untreated ground waters show them to be generally soft and of suitable quality, except for local problems associated with excessive concentrations of Fe and carbon dioxide and a low pH. Water from the Ripley formation, except in the deeper wells far down dip, ranges upward in hardness to more than 200 parts per million and generally is exceeded in hardness only by water from the shallow alluvium of the Yazoo delta. Chemical analyses of surface water indicate that, at base flow, the mineral constituents, the concentration of dissolved solids, and the hardness of surface waters are similar to those of the local ground waters.--Auth.

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See also: Geologic Maps 3-2878, 3-2882; Geochemistry 3-3022, 3-3053; Mineralogy 3-3058, 3-3077, 3-3079; Igneous and Metamorphic Petrology 3-3084.

3-3105. Walenta, Thomas R. RECENT MINING LEGISLATION AND ITS EFFECT ON THE LAW OF DISCOVERY: Idaho, Bur. Mines & Geology, Inf. Circ. 8, 27 p., 1961, 138 refs.

In 1954 Public Law 585 (Multiple Mineral Development of the Same Tract Act) was adopted as a permanent measure to resolve the conflict between the scope and operation of the general mining laws and the Mineral Leasing Act of 1920 in respect to the same tract of land. Public Law 167 (Multiple Use of

the Surface Act) was adopted in 1953 to provide for the multiple use of the surface of the same tract of land, and to correct abuses of the general mining laws. Public Law 359 (The Mining Claims Rights Restoration Act) was passed in 1955 so as to permit the mining development and utilization of the mineral resources of all public lands, heretofore or hereafter withdrawn or reserved for power development. Public Law 85-701 approved Aug. 21, 1958, was designed to provide federal financial assistance in the exploration and discovery of additional mineral reserves. Period for performing annual assessment work is defined by Public Law 85-736. Public Law 85-876 is an amendment of the general mining laws

to include geological, geochemical, and geophysical surveys as valid "labor" in the annual \$100 assessment.

The right to locate a valid mining claim depends upon the discovery of a vein or lode within the limits of the claim. Important court cases bearing upon the sufficiency of discovery are: Castle v. Womble, 1894, Book v. Justice Mining Co. 1893, Burke v. McDonald, 1892, Shoshone Mining Co. v. Rutter, 1895, Ambergris Mining Co. v. Day, 1906, and U.S. v. Merger Mines Corp., 1954.

Public Law 167 removed common varieties of sand, gravel, stone, pumice and cinders from the list of locatable minerals.

The U.S. Supreme Court has settled at least one recent case not upon the sufficiency of discovery, but by the doctrine of *pedis possessio*.--Auth.

3-3106. Markward, Ellen L. GEOCHEMICAL PROSPECTING ABSTRACTS, JANUARY 1955-JUNE 1957: U.S. Geol. Survey, Bull. 1098-B, p. 57-160, 1961.

This compilation of abstracts of papers on geochemical prospecting (exclusive of petroleum) is the third in a series published by the U.S. Geological Survey. The series was initiated by John W. Harbaugh with Bulletin 1000-A, which consisted of abstracts of the pertinent publications through June 1952, and was continued by Jane E. Erickson with Bulletin 1000-G, which began where the preceding work ended and brought the abstracting through 1954. The present bulletin covers the papers published from Jan. 1, 1955, through June 30, 1957, and a few earlier papers not included in Bulletin 1000-G.

Abstracts are in alphabetical order by the names of the authors of the papers abstracted. Several papers, which were not available and for which abstracts were not obtainable, are represented only by title.--From introd.

Author and subject indexes are provided.

3-3107. Nesvetaylova, N.G. GEOBOTANICAL INVESTIGATIONS IN PROSPECTING FOR ORE DEPOSITS. Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3, no. 7, p. 609-618, 2 figs., July 1961, 48 refs.

The use of plants as indicators in prospecting for minerals is discussed on a broad scale from the standpoints of available literature and field experiments. The method of isoline mapping of mineral deposits by means of metal content in ashes of plant parts is described. The author cautions against too broad use of any single species as a "direct" indicator or too heavy reliance on ash content, as some species tend to concentrate certain minerals regardless of soil composition. Instead, a combination of species as indicators and a combination of factors, such as appearance of leaves, luxuriance of the plant, and color and time of blooms, is recommended. The tendency of some minerals to nullify the effect of others - Fe counteracting the effect of Cu, for example - is noted; also different salts of the same mineral have different effects on plants. In spite of these qualifications and the early stage of development of this technique, the method has particular merit in areas where the alluvium overlying the metal-bearing deposits is relatively thick. Analyzing the ash content of leaves of deep-rooted trees is particularly helpful in detecting the presence of an ore mineral in such a situation.--A. Eustus.

3-3108. Buyalov, N.I., and A.M. Shvyryaeva. GEOBOTANICAL METHOD IN PROSPECTING FOR SALT OF BORON. Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3, no. 7, p. 619-625, 4 figs., July 1961, 6 refs.

The successful use of geobotanical indicators in prospecting for B-bearing mineral deposits is described. Three types of indicators were found to apply to 3 situations where B is present in varying degrees or combinations with other chemical elements: 1) where B content is very high, sections may be devoid of plant life or support *Salsola nitraria* Pall and *Limonium sufruticosum* Ktze.; 2) where the Mg content of ascharites counteracts the effect of the B, *Eurotia ceratoides* C.A.M. congregations may indicate sulfate-carbonate soil salinity; and 3) where B content is in the order of tenths of 1%, plants are oppressed, deformed, or subject to plant diseases. A very low B content, such as on old mineralized banks, on the other hand, stimulates plant growth.--A. Eustus.

3-3109. Malyuga, D.P., and others. BIOGEOCHEMICAL INVESTIGATIONS IN KADZHARAN, ARMENIAN SSR: Geokhimiya, in translation, 1959, no. 5, p. 519-528, 6 figs., 2 tables, pub. 1960, 7 refs.

A biogeochemical localization of plant associations to the definite types of intrusive and extrusive rocks has been established: the thyme-tragacanth association is found over monzonites and the assemblage of leguminous plants, over andesites.

There is a preferential development of the drooping astragalus (*Astragalus declinatus* W.) on the hydrothermal Cu-Mo zones.

The Mo content in the plant roots reaches tenths of 1% (in ash).

A modified form of the poppy *Papaver commutatum* F. et M. with unusual development of black coloration on the petals (black cross) was found. This form is localized on ground water seepages enriched in Cu and Mo at the Karmir-Kara area of the Kadzhar deposit.

The variation in the large-pod poppy (*Papaver macrostomum* B. et H.) growing over the Atkyz polymetallic deposit in the Kradzhar region has been studied. The change in the petals of the poppy consists in the various degrees of lobation. The extreme forms have additional petals (double flower) not usually found in this species of poppy.

The ecological variations in plants growing over Cu-Mo and polymetallic deposits may have theoretical and practical (prospecting) significance.--Auth. summ.

3-3110. Ermakov, N.P. IMPORTANCE OF INCLUSIONS IN MINERALS TO THE THEORY OF ORE GENESIS AND STUDY OF THE MINERAL FORMING MEDIUM. Translated by Eugene A. Alexandrov: Internat. Geology Rev., v. 3, no. 7, p. 575-585, 4 figs., table, July 1961, 6 refs.

Inclusions in minerals constitute evidence of past processes. Three types of inclusions are recognized - solidified, gaseous, and liquid. Relations can be drawn between them and the several stages of mineralization - magmatic, pneumatolytic, and hydrothermal. Inclusion thermometry permits analysis of temperature, space, and time relations during mineral-forming processes.--M. Russell.

3-3111. Bryner, Leonid. BRECCIA AND PEBBLE COLUMNS ASSOCIATED WITH EPIGENETIC ORE

DEPOSITS: *Econ. Geology*, v. 56, no. 3, p. 488-508, 3 figs., May 1961, 54 refs

Columns of rock fragments show a wide variety of form and structure and are associated with many different kinds of ore deposits. The fragments range from angular to rounded and from blocks weighing many tons to the particles that constitute a matrix of rock paste. The columns generally develop on planar structures or at structural intersections mostly in competent rocks.

Two broad divisions of mineralized rock fragment columns are proposed, namely prehydrothermal and cohydrothermal. In the prehydrothermal type the spatial coincidence between the column and the ore shoots in most cases is poor because the column developed prior to and independently of mineralization, and other controls besides the configuration of the column were operative in localizing the ore. In the cohydrothermal type there is closer coincidence in time and generally in space between ore and the column because the column results from the corrosive action of the hydrothermal fluids.

Tectonic breccias, volcanic vent fillings, intrusive igneous breccias, and filled sink and circle deposits formed by ground water leaching of carbonate rocks, generally come under the heading of prehydrothermal structures. Other breccia columns, hydrothermal pebble dikes, and probably most porphyry Cu deposits come under the heading of cohydrothermal structures.

The incidence of ore most likely is higher in cohydrothermal than in prehydrothermal structures though important ore deposits occur in both types.--Auth.

3-3112. Hawley, J. E., and Ian Nichol. **TRACE ELEMENTS IN PYRITE, PYRRHOTITE AND CHALCOPYRITE OF DIFFERENT ORES:** *Econ. Geology*, v. 56, no. 3, p. 467-487, 2 figs., 10 tables, May 1961, 25 refs.

Trace element determinations on pyrite, pyrrhotite and chalcopryrite from magmatic Ni ores, and hydrothermal Cu and Au ores indicate that 1) certain elements, especially Co and Ag, and to a lesser extent Ni and Pb, show a preferential concentration in the 3 sulfides; 2) that some significant variations occur in deposits of different type and in different deposits of similar type; and 3) that there is a striking qualitative similarity in trace elements of all the deposits. Possible interpretations are given. These favor magmatic sources for the ores and suggest local contamination of rising ore fluids as a cause of some of the variations.--Auth.

3-3113. Fischer, Richard P., and John H. Stewart. **COPPER, VANADIUM, AND URANIUM DEPOSITS IN SANDSTONE - THEIR DISTRIBUTION AND GEO-CHEMICAL CYCLES:** *Econ. Geology*, v. 56, no. 3, p. 509-520, 2 figs., 2 tables, May 1961, 26 refs.

Deposits of Cu, V, and U in nonmarine sandstones are numerous and widespread. Cu deposits, with or without U, are mainly resident in first-generation arkosic sandstones derived from granitic rock terrains; deposits rich in V, with or without much U, are dominantly in second-generation sandstones derived from sedimentary rocks; and the U deposits with little or no V or Cu are in either first- or second-generation sandstones, many of which are associated with beds containing volcanic debris.

All 3 metals are dispersed in igneous rocks but not in close association. Cu and U enter the hydrother-

mal environment, but the record of V in hydrothermal solutions and veins is scant. Some of the U and most of the Cu minerals in igneous rocks and veins oxidize readily and the metals go into surface- and ground-water solutions, but the V in igneous rocks is not so easily mobilized - under normal geologic conditions, conceivably it may require diagenetic reactions and a second period of weathering to solubilize much V. All 3 metals precipitate from solutions in the presence of a reducing agent, such as carbonaceous material or associated sulfide ions, either in sediments as they accumulate or in existing rocks.

These geochemical habits permit the concept that Cu and U are made available by weathering of igneous rock terrains and hence might accumulate in first-generation sediments, whereas V would be commonly available only after a second period of weathering. Perhaps the oxidation or devitrification of volcanic debris may contribute U to ground waters as does the weathering of igneous rocks.--Auth.

3-3114. Kosterin, A. V. **THE POSSIBLE MODES OF TRANSPORT OF THE RARE EARTHS BY HYDROTHERMAL SOLUTIONS:** *Geokhimiya*, in translation, 1959, no. 4, p. 381-387, pub. 1960, 15 refs.

The main mass of the rare earths in hydrothermal deposits was most probably brought in by solutions in the form of a $[\text{RE}(\text{CO}_3)_3]^{3-}$ complex. In some deposits containing large amounts of barite the rare earths could have been brought in by solutions in the form of sulfate complexes and double salts. The transport of the rare earths in the form of fluoride complexes is evidently unimportant because of the absence in the hydrothermal solutions of the required excess of the Fe^{3+} , Al^{3+} , Zr^{4+} , and other cations over the rare earths.

If the complex of the $[\text{RE}(\text{CO}_3)_3]^{3-}$ type is the principal form in which the rare earths are transported by hydrothermal solutions, then the main causes of the breakdown of the complex and the crystallization of the rare earth minerals are: a) decrease in pressure resulting from the entry of the solutions into cavities and fractures, b) decrease in alkalinity of the solutions due to the fixation of the cations of strong bases (K and Na) by the reaction between the solutions and the country rock, c) the fixation of CO_3^{2-} in insoluble carbonates precipitated from the solution (calcite, siderite, etc.).

Because the Y earths form much more stable carbonate and sulfate complexes than the Ce earths, the former become relatively enriched in the hydrothermal solutions. This process may be accelerated by the crystallization of minerals removing the Ce earths from the solutions, or be slowed down or even reversed by the formation of minerals preferentially withdrawing the Y earths.--Auth. summ.

3-3115. Gindy, Amin R. **RADIOACTIVITY AND TERTIARY VOLCANIC ACTIVITY IN EGYPT:** *Econ. Geology*, v. 56, no. 3, p. 557-568, 5 figs., May 1961, 17 refs.

Tertiary tectonic disturbances in Egypt produced widespread basaltic fissure eruptions and diverse hydrothermal activities that include Cu, Fe, Fe-Mn, and Pb-Zn mineralizations. Studies on the trace radioactivity of some of these deposits suggest the presence of a weak uraniferous phase in some or in certain stages of these hydrothermal activities, and can explain the known occurrences of economic U deposits in Egypt.

These volcanic hydrothermal solutions were not

originally uraniferous but have become so during their ascent by leaching and mobilizing preexisting labile U and other ions in the traversed rocks.--Auth.

3-3116. Williamson, D.R. **GUIDE TO COLORADO GOLD DEPOSITS:** Colorado School Mines, Mineral Industries Bull., v. 4, no. 3, p. 12, map, diag., May 1961, 232 refs.

This comprehensive review deals with the history, areal geology, and specific ore deposits of the Colorado Au mining industry. Introductory comments include a digest of the current economic situation affecting the operation of mines and exploration for new deposits.

Mention is made of geologic conditions connected with Au occurrences. Detailed geologic comments are included on the Front Range mineral belt of Colorado.--W.C. Peters.

3-3117. Woodtli, Robert. **RELATIONSHIPS OF GENERAL STRUCTURE TO GOLD MINERALIZATION IN THE KILO AREA (CENTRAL AFRICA):** Econ. Geology, v. 56, no. 3, p. 584-591, 2 figs., May 1961, 7 refs.; abs. in English and French.

The Au mines of Kilo [Congo] have been successfully worked since the beginning of the century; placers are now exhausted and output comes from primary deposits. Mineralization occurs in quartz veins occupying shear zones and dislocations associated with an old tangential structure. Young radial structures connected with rift tectonics affect the mineralized belts and dislocate the deposits.--Auth.

3-3118. Woodtli, Robert. **GOLD IMPREGNATION DEPOSITS IN THE MOTO AREA (CENTRAL AFRICA):** Econ. Geology, v. 56, no. 3, p. 603-607, May 1961, 4 refs.; abs. in English and French.

A short description is given of impregnation deposits of the Moto Au field in the NE. part of the Republic of Congo. These ore bodies are located in a Precambrian schistose rock containing carbonate, quartz, and albite due to metasomatic processes. There is no correlation between quartz stringers, abundance and composition of sulfide, and Au grade. A low-grade halo furnishes a valuable guide in the exploration for new ore bodies. Other significant features include a remarkable parallelism between the ore bodies (direction NNE., dip 24°) conformity to rock foliation, occurrence of itabirite and black schists, and some lenticular sulfide bodies.--Auth.

3-3119. Stoll, Walter C. **CONTACT METASOMATIC COPPER MINERALIZATION AT THE CALZADA MINE, PERU:** Econ. Geology, v. 56, no. 3, p. 612-613, May 1961.

A quartz pebble conglomerate formation up to 70 m. thick has a matrix that has been almost completely replaced by silicates and sulfides. The introduced minerals, rich in Ca, Fe, Cu, and S are typically of metasomatic origin. They are probably related to granitic intrusives although no such rocks are exposed at the mine.--J. A. Chamberlain.

3-3120. Bounsall, E.J. **THE CONTENT OF TRACE AMOUNTS OF SILVER IN GALENA ORES FROM BROKEN HILL, AUSTRALIA:** Econ. Geology, v. 56, no. 3, p. 608-611, 2 tables, May 1961, 5 refs.

A quantitative method of chemical analysis for the determination of Ag in Pb ores has been developed and applied to samples from the Broken Hill region of Australia, whose Pb isotope compositions had been previously determined. The results of the analyses do not indicate any significant difference in Ag content that can be correlated with differences in isotopic composition or the type of Pb ore.--Auth.

3-3121. Newton, Joseph, and others. **STUDY OF TWO IDAHO THORITE DEPOSITS:** Idaho, Bur. Mines & Geology, Pamph. no 122, 53 p., 12 illus., 1960, 20 refs

Th is a radioactive metal of great potential importance as a nuclear fuel. Professor Newton, in the first chapter, discusses the properties, radioactivity, fission, extractive metallurgy, tenacity, and uses of Th.

In the second chapter Denis Le Moine outlines the geologic characteristics of a thorite deposit on Hall Mountain, Boundary County, following which Clark Adams gives the results of his attempts to concentrate the Hall Mountain thorite. The fourth chapter by Dr. A. L. Anderson describes thorite occurrences in the Lemhi Pass area of Lemhi County, and in particular the Cago No. 12 deposit from which the ore came that was used by J. A. Shively in his beneficiation tests, outlined in the fifth chapter. The last chapter by Professor Newton, is a summary of the experimental laboratory work.--Auth.

3-3122. Reid, Rolland R. **PLACER DEPOSITS OF THE ELK CITY REGION:** Idaho, Bur. Mines & Geology, Pamph. no 121, 26 p., 3 maps (geol. map in pocket, scale approx. 1 in. to 1 1/2 mi.), profiles, 1960, 12 refs.

Stream placer gravel in the Elk City region; Idaho, aggregates about 55 million cu. yds., about 25 million yds. of which has already been mined for its Au content. The average amounts in pounds per cubic yard of potentially valuable heavy minerals in 15 samples of stream placer gravel in the Elk City region are as follows: allanite - 0.2 lbs.; monazite - 0.15 lbs.; rutile - 0.07 lbs.; brookite - 0.1 lbs.; sphene - 0.1 lbs.; zircon - 0.25 lbs.; ilmenite - 6.9 lbs.; and magnetite - 16.8 lbs.; the average total of heavy minerals, 27 pounds per cubic yard. Brannerite, euxenite, and columbite are present in trace amounts. Judged by these figures, the deposits are noncommercial at present.

The volume of Tertiary basin gravels and sands is not accurately known, but is probably more than 100 million cu. yds. The outcrop area of such beds in the Elk City region is about 18 sq. mi., with a probable average thickness of more than 60 ft. The average amounts in pounds per cubic yard of potentially valuable heavy minerals in 4 small grab samples of the Tertiary deposits are as follows: monazite - 1.6 lbs.; rutile - 0.3 lbs.; brookite - 0.3 lbs.; zircon - 1.5 lbs. These relatively large amounts serve to indicate that further testing of the Tertiary gravels may be of value.

The Elk City region is underlain predominantly by biotite gneiss from which, all the data in hand indicate, the major part of the heavy mineral content of the placer deposits was derived.--Auth.

3-3123. Fountain, Richard C. **A CONTRIBUTION TO THE PETROGRAPHY OF THE SILURIAN IRON ORES OF NORTHWEST GEORGIA:** Georgia Mineral

Newsletter, v. 13, no. 3, p. 114-116, 4 illus., Fall 1960.

The predominant minerals in the ore are hematite, calcite and quartz. The hematite occurs as matrix and as fossils; the quartz occurs as subrounded detrital grains.

Examinations of etched slides and of thin sections are described and recorded. Conclusions are drawn from data that the environment was shallow-water marine; that the primary sediment had a high carbonate content; that there was precipitation of iron oxide after the accumulation of biogenic hash but before its consolidation; that there were slight fluctuations in deposition environment.--J. G. Lester.

3-3124. Meave T., Edgardo, and José Echegoyén S. ESTUDIO GEOLOGICO-ECONOMICO SOBRE ALGUNOS YACIMIENTOS DE MINERAL DE HIERRO EN LOS MUNICIPIOS DE PIHUAMO Y TECALITLAN, JALISCO [GEOLOGIC-ECONOMIC STUDY ON SOME IRON ORE DEPOSITS IN THE MUNICIPALITIES OF PIHUAMO AND TECALITLAN, JALISCO]: Mexico, Consejo de Recursos Naturales no Renovables, Bol. 53, 88p., 26 illus., 44 pls. (13 in pocket incl. maps), graph, 11 tables (1 in pocket), 1961; text in Spanish.

The scope that the then National Institute for the Investigation of Mineral Resources proposed on ordering the study of the ore deposits, described in the Bulletin, was to determine the economic potentiality of that practically unknown area. The surveys were carried out from the end of Nov. to the beginning of Jan. 1954.

The ferrous mineral deposits are situated in the extreme SW. of the state of Jalisco, in the municipal jurisdiction of Pihuamo and Tecalitlan, and in the western watershed of the Sierra de El Alo. The deposits are considered to be divided into 2 zones: the Sierra de El Alo deposits, and the Pihuamo deposits.

The Sierra de El Alo deposits are situated on the western slope, where they occupy a roughly rectangular area of some 5 km. by 2 km., oriented NE. The most important settlement in the vicinity of these deposits is Los Tajos Ranch, about 20 km. to the E. of Pihuamo. Approximately 1 km. NE. of Los Tajos, is the El Sancito deposit. NE of Los Tajos at 2, 4, and 5 km. respectively, are the El Presidio, El Guayabito, and La Desconfianza deposits. These deposits belong to the municipality of Tecalitlan, Jalisco.

The Pihuamo deposits are localized in saddles of the western watershed of the Sierra de El Alo; they are distributed in an approximately rectangular area 20 by 12 km. The most important town in the vicinity of the deposits is Pihuamo, which is located approximately to the NE. The deposit most distant from Pihuamo is called El Enuno, and is 12 km. directly to the S. The nearest deposits are localized in gullies of the Rio de Pihuamo and in Agua Fria at most 2 1/2 km. to the S.

The regional geology is very complex, and since a systematic investigation has not been made, only the areas directly related to the deposits were studied; these are widely distributed, and in some cases, until they are genetically distinct, it will be desirable to describe each of them. The description of the principal rocks that outcrop in the region is in accordance with their importance in each of the deposits. The stratification was determined with relation to the deposits of primary importance, since this has been studied in greatest detail, enabling it in general to be applied to the entire region.

The deposits present distinct origins, being of 2 principal types, those of pyrometamorphic contact (Chilillo, Llano de Venado, Cofradia, Piedra Iman, Agua de Perro, San Antonio, those of Sierra de El Alo and part of the El Encino deposits) and those injected by residual liquids (Relumbrosa and Mangos): Ludo Grande and Yunque, Rio de Pihuamo, and perhaps El Encino.

Apparently the magma was enriched in Fe since the associated igneous rock lacks ferromagnesians. Parts of these residual liquids rich in Fe crystallized at high temperature and pressures in the contact of the intrusive with the limestone; another part was injected into the compacted rock and another part, perhaps, crystallized without any great movement.

The deposits probably were formed toward the end of the consolidation of the intermediate rocks; they correspond to the base of the Tertiary, as the result of igneous activity which corresponds to the Laramide revolution.

The conclusions cited on finishing the work are as follows: The quality of the Fe mineral in the studied deposits is fairly good. In the El Encino deposits, the average Fe content of the analyzed specimens is 60.43%, the S is under 0.133%; they are however, high in P with an average of 0.318%.

The tonnage represented by each of the deposits is sufficiently great to cover costs except for the San Antonio deposit, the only value of which is scientific.

With respect to the Sierra de El Alo deposits it should be mentioned that only a brief survey was made, since the tonnages present are minimum.--Auth. translated by Research International Associates.

3-3125. Vakhrushev, V. A. MINERALOGICAL-GEOCHEMICAL ZONING IN THE IRON DEPOSITS OF THE KONDOMA REGION OF GORNAYA SHORIYA: Geokhimiya, in translation, 1959, no. 4, p. 471-478, 5 tables, pub. 1960, 4 refs.

Mineralogical zoning within the Kondoma group of Fe deposits (western Siberia) is sharp. Tabular data shows the most characteristic gangue mineral assemblages which are related to the skarn-ore deposition; a list of the hypogene ores in order of abundance at each of the 4 principal deposits; the chemical composition of magnetites at the deposits; the average Zn and Ga content of the magnetites; and the average content of admixed elements in the magnetites. A second stage of mineralization related to a granitic pluton produced independent ore deposits and was superimposed on the primary contact metasomatism, masking and complicating the original zonation of the ores.--M. Russell.

3-3126. Davis, S. G. MINERALOGY OF THE MA ON SHAN IRON MINE, HONG KONG: Econ. Geology, v. 56, no. 3, p. 592-602, 9 figs., May 1961, 6 refs.

The Ma On Shan Fe mine in the Leased Territories of Hong Kong has proved reserve of 10 million tons of magnetite. The mine, which until 1957 was worked open-cast, is about 250 m. above sea level in an area of rugged topography. There are about 2,000 m. of underground workings. The production of ore in 1959 was 119,800 tons.

The major rock groups exposed are granites and volcanics that range in age from middle Jurassic to late Cretaceous. The magnetite ore body is lens-shaped and dips gently to the NW. These rocks have been affected by major earth movements and volcan-

ism during early Tertiary times.

The typical mineral association of the main ore body is magnetite and chondrodite. Surrounding the magnetite is a skarn with a mineral assemblage that includes talc, serpentine, garnet, olivine, pyrite, chalcopyrite, and fluorite. At the base of the skarn there are beds of calcite, dolomite, and quartzite. The ore body is highly disseminated. A ball-mill using a wet magnetic separator beneficiates it to 56% Fe. Almost the entire output goes to Japan. Quartz veins in the country rocks carry wolframite and Mo. Some oxidation and supergene enrichment are present. The mineral assemblage of the skarn in the deposit suggests a contact pyrometamorphic origin. The mineral chondrodite is typical of such a deposit and its occurrence explains why the content of magnetite is so high in the Fe ore.--Auth.

3-3127. Reid, Rolland R., and Raoul Choate. PROSPECTING FOR BERYLLIUM IN IDAHO: Idaho, Bur. Mines & Geology, Inf. Circ. 7, 19p., 2 illus., 1960, 14 refs.

Be is valued for its light weight and other properties such as strength and high melting point. It is presently used mostly in alloys with Cu, but is sure to be used increasingly in nuclear reactors. There are 2 companies which now extract and process Be and 5 companies which are consumers of beryl. Beryl exploration is assisted by the Government up to 50% of the total allowable cost. Concentration of fine-grained Be is difficult; selective flotation appears to be the most promising method.

Major Be-bearing minerals are: bertrandite, beryl, chrysoberyl, helvite, and phenakite (phenakite). Minor Be-bearing minerals include the following: axinite, allanite, fergusonite, garnet, vesuvianite, samarskite, thorite, and zircon. Beryl occurs for the most part in zoned granitic pegmatites, but it also is found in granitic and syenitic intrusive rocks, and in high-temperature quartz veins. Helvite occurs in contact-metamorphic deposits and seldom occurs in Mn-Pb-Zn veins as at Butte, Montana. Bertrandite occurs in pegmatites and in high-temperature veins. Chrysoberyl and phenakite occur in pegmatites as accessory minerals.

Be is found in Idaho in pegmatites and as disseminated aquamarine in granite over an area of several square miles in the vicinity of Glen's Peak at the head of the Middle Fork of the Boise River. None of the occurrences appear to be of commercial value. Green beryl and aquamarine occur over an area of a few square miles in porphyritic granite along the Cathedral Rock road, 15 mi. W. of Cobalt, Idaho. Beryl was produced for many years from zoned pegmatites at the muscovite mine near Deary, Idaho. Several high-temperature quartz-aquamarine veins and veinlets have been found in the Sheep Creek area, 5 mi. E. of the Middle Fork of the Boise River. Fluorite is one of the most favorable Be indicator minerals; scheelite is also important.

Favorable prospecting areas in Idaho include the following: The Sawtooth mountains, western border of Idaho batholith, Yellowpine district, Wildhorse Creek-Trail Creek area, Deadwood Reservoir area, Mackay area, Stanley Basin area, Northern Lemhi Mountains, near Agency Creek in Beaverhead Mountains, Yankee Fork-Red Mountain area, Upper Middle Fork of the Salmon River. Prospecting methods include use of the beryllometer, colorimetric and fluorimetric chemical tests, and spectroscopic tests.--Auth.

3-3128. Wheeler, Dooley P., Jr. INTRIGUING EXAMPLES OF GEOLOGY APPLIED TO INDUSTRIAL MINERALS: Econ. Geology, v. 56, no. 3, p. 617-618, May 1961.

Discussion of a paper by J. L. Gillson (GeoScience Abstracts 2-2420). Fluorspar does not generally occur as a "lone wolf" but rather as a gangue mineral in ore deposits, associated with one or more of: Sn, W, Be, Mo, Cu, Zn, Pb, Ag, Au, U, and Mn. Epigenetic fluorspar and Mn can act as guides in the search for new centers of mineralization.--J. A. Chamberlain.

3-3129. [Furcron, A. S.] CORUNDUM IN GEORGIA: Georgia Mineral Newsletter, v. 13, no. 4, p. 167-177, 3 illus., 3 maps, Winter 1960, 12 refs.

A summary of known corundum occurrences in Georgia. Localities are described in Carroll, Cherokee, Cobb, Douglas, Habersham, Hart, Heard, Morgan, Paulding, Rabun, Towns, Troup, Union, Upson, and Walton counties.--J. G. Lester.

3-3130. Smith, James William. TALC, SOAPSTONE, AND RELATED STONE DEPOSITS OF VIRGINIA: Virginia Minerals, v. 7, no. 2, p. 1-8, 13 figs., Apr. 1961, 7 refs.

In Virginia, dimension stone is produced from soapstone and serpentinite at Schuyler, it is quarried from rocks related to soapstone at Lynchburg, and ground soapstone is produced at Schuyler and Henry. The principal producing rock is the Precambrian Lynchburg formation. Talc and soapstone have also been commercially produced from Fairfax, Orange, Fluvanna, Amelia, Campbell, Floyd, and Grayson counties.--M. Russell.

3-3131. Kelley, D. G. PROSPECTING FOR METALLIC MINERALS IN MISSISSIPPIAN ROCKS OF CAPE BRETON ISLAND, N.S.: Canadian Mining Jour., v. 82, no. 6, p. 69-71, map, June 1961, 7 refs.

Recent attention has been drawn toward mineral deposits in the Mississippian rocks of Nova Scotia. Although widespread but minor mineralization in the lower Carboniferous was reported as early as 1880, little interest was gained until the 1957 discovery of lead-copper-zinc sulfides in significant quantity near the Magnet Cove barite mine on the mainland. By 1960, prospecting had spread to the Mississippian rocks of Cape Breton Island.

Mississippian rocks include the Horton, Windsor, and Canso groups. The best prospecting ground, as supplemented by recent geochemical data, is near the base of the Windsor group and along the Horton-Windsor contact. Metallic mineral occurrences along the Horton-Windsor contact in Cape Breton include those at Jubilee, Arichat, Lake Ainslie, and South Aspy river. There are numerous other promising occurrences.

The major mineral concentrations are epigenetic, although the original minerals must have been deposited with the sediments. Concentrations are most likely where there are folds and faults transverse to the regional structure.--W. C. Peters.

3-3132. Peyton, Garland, and others. THE MINERAL INDUSTRY OF GEORGIA: Georgia Mineral Newsletter, v. 13, no. 4, p. 146-151, table, Winter 1960, 7 refs.

Mineral production in Georgia in 1959 amounted to \$86.3 million, an increase of 15%. This review is by mineral commodities (nonmetals, metals, mineral fuels) and by counties. Sixty-seven of Georgia's 159 counties are listed.--J. G. Lester.

3-3133. Furcron, A. S. SOME LOST MINERAL LOCALITIES IN GEORGIA: Georgia Mineral Newsletter, v. 13, no. 3, p. 124-129, Fall 1960, 21 refs.

An historical treatment of known occurrences, reported occurrences, and legendary occurrences in Georgia of cassiterite, spodumene, Pb and Ag, opal, epidote, and cacozenite. The article shows very plainly how the lack of accuracy in location creates confusion, and in many cases brings about the complete loss of mineral deposits.--J. G. Lester.

3-3134. Bolino, August C. THE ROLE OF MINING IN THE ECONOMIC DEVELOPMENT OF IDAHO TERRITORY: Idaho, Bur. Mines & Geology, Inf. Circ. 6, 38 p., 2 illus., 1960, 102 refs.

The first recorded Au discovery in Idaho was made by Capt. John Mullan in 1858 or 1859. However, it was the discovery of Au near Pierce in 1860 by Ed Pierce that started the mining industry in Idaho. The first mines in Idaho were within packing distance of the Columbia River, but the later mines in Boise basin and near Silver City presented problems in transportation. Both placer and quartz mines were operated in early Idaho mining. Arrastras were used first in the quartz mines; these were replaced later by stamp mills. In the Wood River region smelting was attempted but failed due to the high cost of obtaining coke.

About 1880, increasing availability of capital and advancing technology brought a more permanent phase to the Idaho mining industry and marked the transition from isolated small-scale mining to organized, large-scale, capitalistic mining. It was mining that brought the essential requirements, labor, capital, technology and industrialization, for rapid and sustained economic growth to Idaho.--Auth.

3-3135. Schoewe, Walter H. THE MINERAL INDUSTRY IN KANSAS IN 1959: Kansas, State Geol.

Survey, Bull. 142, pt. 6, p. 235-289, 8 figs., 35 tables, 1960, 19 refs.

Mineral production in Kansas in 1959 exceeded \$500,000,000 for the fourth consecutive year. Total value of all minerals produced or processed in the state was \$524,634,619, an increase of 2.6% from 1958. Of the total, \$442,788,460 or 84.39% came from sale of mineral fuels and associated products, \$81,501,619 or 15.54% was contributed by the nonmetals excluding mineral fuels, and \$344,540 or 0.65% by the metals. Production and value of coal, He, natural gasoline, LP gases, oil or petroleum, and Zn in 1959 were each less than in 1958; all other mineral commodities showed increases.

Again 3 of the 105 counties in Kansas reported no mineral production in 1959; Mitchell County joined the producing counties, but Ottawa County reported no mineral production in 1959. Oil, gas, or both were produced in 82 counties, sand and gravel in at least 71 counties, and stone in 41 counties. In 1959 each of 59 counties, 5 more than in 1958, produced minerals worth \$1,000,000 or more. Barton County again led in the value of mineral production (\$34,775,252), followed by Ellis County (\$33,391,076) and Russell County (\$27,216,157). Butler, Grant, and Graham counties also each produced minerals worth more than \$20,000,000. In the \$10,000,000 to \$20,000,000 category were 13 counties, one more than in 1958. Only 7 of the counties producing \$1,000,000 or more in mineral wealth in 1959 produced mainly nonfuel minerals, and 6 of these are in eastern Kansas. The counties that produced the greatest dollar value of minerals are those in which oil is found, mainly western Kansas counties, although Allen, Butler, and Greenwood counties, all in eastern Kansas, are included in the list. Counties that exploited the most different minerals were Cherokee and Reno, 7 minerals each, and Barber, Grant, Kearny, Kingman, and Sedgwick, 6 minerals each. The minerals that led in value were oil, natural gas, portland cement, stone, salt, clay and clay products, carbon black, butane, and coal. This report gives the amount and value of all minerals produced in the state in 1959 and compares them with 1958 statistics, and it also includes directories of mineral producers on record as of Dec. 31, 1959. A brief summary of mineral production, value, and trends in Kansas for the 1950-1959 decade concludes the report.--Auth.

13. FUELS

See also: Geologic Maps 3-2858, 3-2879, 3-2880, 3-2881; Structural Geology 3-2913; Stratigraphy 3-2922, 3-2926 through 3-2930; Paleontology 3-2955, 3-2956; Engineering Geology 3-3161.

3-3136. Koepf, Ernest Henry, and Raymond James Granberry. THE USE OF SIDEWALL CORE ANALYSIS IN FORMATION EVALUATION. Jour. Petroleum Technology, v. 13, no. 5, p. 419-424, 6 figs., 4 tables, May 1961, 8 refs.

Analytical techniques and procedures which permit accurate measurement of important physical properties and of fluid content of sidewall core samples received in the laboratory are available. However, hole conditions prior to and during sampling affect the values as measured on the core samples. Also, the impact of the percussion sampler in the sampling process alters some of the physical characteristics of the sample. Comparisons of data on conventional and sidewall core samples and ex-

perience have shown the general direction of these effects. Normally, formations along the Gulf Coast have a greater productive capacity than the sidewall core sample data indicate. Water saturations associated with gas, condensate or oil production are greater in sidewall than in conventional core samples. Sidewall core data are valuable as exploratory aids, but data from conventional or wireline cores are generally required for evaluating recoverable reserves, the distribution of reservoir fluids and formation flow characteristics.

Sidewall core data usually establish the presence or absence of hydrocarbon content and indicate the probable type of production. Measured permeability and porosity values indicate productive capacity. The data show gas-oil and water-oil contacts. Sidewall sample data are particularly valuable as a basis for "calibrating" electrical log data. They are used to check lithology changes indicated by log data, and they permit evaluation of thin and stray sands. Side-

wall core samples probably provide the most reliable data normally obtained on "dirty" or ashy sand zones which show low resistivity on the electrical logs, on sand sections drilled with high-salt-content muds and on shallow bentonitic sands containing fresh water. Consideration of both sidewall core analysis data and electrical log data together increases the value of each. In many instances, it is necessary to consider both types of data in arriving at a correct interpretation. Greatest value can be obtained from the sidewall core data if the analyst has an electrical log of the zone as a guide for general formation characteristics and for zoning the various samples. --Auth.

3-3137. Dewan, J. T., and others. CHLORINE LOGGING IN CASSED HOLES: Jour. Petroleum Technology, v. 13, no. 6, p. 531-537, 7 figs., June 1961, 9 refs.

A new chlorine logging tool, developed primarily for the detection of oil saturation behind casing, is described. The principle involved is the selective detection of gamma radiation from neutron capture in chlorine. The tool is relatively insensitive to porosity, responding mainly to the concentration of chlorine in the interstitial liquid rather than to the total chlorine content in the formation.

A brief review of the fundamentals of chlorine logging is given. This includes a discussion of the partition of neutron captures in clean sand and limestone formations, and the spectra of gamma rays obtained. The effect of neutron capture in Fe is shown to be important.

Following a short description of the logging tool, the laboratory-determined response of the instrument in cased sandstone formations is presented. It is shown that better results can be obtained by logging in empty casing than in casing filled with oil, fresh water, or salt water. Effects of neutron capture in the casing, casing liquid, cement annulus and formation matrix are discussed.

A method of interpreting the Chlorine log, based on the use of the response curves, is explained. This is illustrated with several field examples which also show comparisons of electrical and Chlorine logs. In Gulf Coast formations, the Chlorine log often bears a marked resemblance to the SP curve, and in some cases water-oil contacts have been identified by a visual comparison of the 2 curves. Comparison of the Chlorine log with a neutron log is also valuable in interpretation. The role of the neutron log is to give a porosity (which need be approximate only), to indicate formation shaliness and, most important, to identify gas which is generally indistinguishable from oil on the Chlorine log.

The Chlorine log should prove most useful in old wells where adequate open-hole logs do not exist, or where saturation conditions in the producing zone have changed. The combination of the Chlorine log with a Cement Bond log and the wireline formation tester should aid materially in successful reworking of such wells.--Auth.

3-3138. Baranov, V.I., and others. THE RADIO-METRIC METHOD OF EXPLORATION FOR PETROLEUM AND GAS DEPOSITS: Geokhimiya, in translation, 1959, no. 6, p.643-652, 4 figs., 2 tables, pub. 1961, 12 refs.

Samples of the surface layer of rocks at a depth of 25 cm. on the gas-petroleum deposit Kizyl-Kum and the underground structure Gekcha (western Turk-

menia) were selected and analyzed to determine the cause of the typical distribution of intensity of γ -radiation which is observed on several oil-bearing areas.

The results of analyses showed that the distribution of γ -radiation is related to a parallel change in the concentration of all radioactive elements (U, Ra, Th, and K).

Ra is contained in oil gases in quantities not sufficient to cause the observed change of intensity of γ -radiation along the outline of the deposit.

These results bear witness of the fact that on the above structures the hypothesis of a relation between the γ -radiation, being typical of several oil-deposits and the precipitation of Ra or of their daughter products on the outline of the oil-bearing bed is not confirmed.--Auth.

3-3139. Vostokova, E. A., and others. GEOBOTANICAL INDICATORS OF BITUMEN. Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3, no. 7, p. 598-608, 6 figs., 4 tables, July 1961, 9 refs.

Abnormal plant growth and early or second flowering are related to the bitumen content of soils. While such abnormalities have previously been noted, geobotanists of the 1950 All-Union Aerogeologic Trust expedition carried the study to a more definitive level. By comparing vegetation of known bitumen-bearing sections against "control" sections, they related specific abnormalities of plants to the presence of bitumens. The studies were carried out in arid regions of western Kazakhstan and the northern Caspian Sea coast. Plants were classed according to whether the abnormalities were 1) of unusual size without alteration of the original form, for which 28 species are listed; 2) notably increased branching, 8 species; and 3) second blooming, 12 species. Other abnormalities and distortions are described. Subsequent investigations testing the preliminary data shows that plants are reliable indicators of oil bitumens in the soil.--A. Eustus.

3-3140. Montgomery, Edwin H. THE WHITE ROCKS THAT BURNS, OIL SHALE ON THE NATIONAL LAND RESERVE: U.S. Bur. Land Management, Our Public Lands, v. 10, no. 4, p. 5-7, 14-15, 5 illus., Apr. 1961.

Oil shale has been recognized since the 17th century as a source of oil. Presently known reserves in the U.S. would satisfy our needs, at present demand, for 300 years. Cost of recovery has been reduced to 30 cents a barrel, but operations still remain largely at pilot-plant level. The distribution, literature, and status of development of recovery efforts of oil shale in the U.S. are summarized.--M. Russell.

3-3141. California, Division of Oil and Gas. SUMMARY OF OPERATIONS, CALIFORNIA OIL FIELDS. FORTH-SIXTH ANNUAL REPORT OF THE STATE OIL AND GAS SUPERVISOR: Its: v. 46, no. 1, 130 p., maps (10 in pocket), graphs, tables, Jan.-June 1960, refs.

Contains 10 oil field reports which cover history, structure, stratigraphy, producing zones, drilling and production statistics for each field. The reports cover: Dudley Ridge gas field; Cantua Creek area of Fresno County; Strand oil field; Rio Bravo oil field; Midway-Sunset oil field, Exeter and 29-D pools; San Emidio Nose oil field; Saticoy oil field; East Coyote oil field; Kraemer oil field; and Hyperion oil field.--L. M. Dane.

3-3142. California, Division of Oil and Gas. CALIFORNIA OIL AND GAS FIELDS, MAPS AND DATA SHEETS. PART I. SAN JOAQUIN-SACRAMENTO VALLEYS AND NORTHERN COASTAL REGIONS: 193 p., maps, secs., tables, San Francisco, Oct. 1960, refs.

Historically there have been 4 major areas or basins of oil or gas production. These are Los Angeles, San Joaquin-Sacramento (the Great Valley), Ventura, and Santa Maria. Recent years have brought 2 new valleys, Cuyama and Salinas, into lesser but still considerable importance. This part covers the San Joaquin-Sacramento valleys and the northern coastal region. The remainder of the state comprising the San Diego to San Mateo coastal regions will be covered in Pt. 2.

Oil occurs in the San Joaquin Valley largely in the Pliocene, Miocene, and Eocene, with lesser amounts in the Pleistocene and Oligocene and very minor amounts in the Cretaceous and Jurassic. Dry gas is the only production of the Sacramento Valley. Gas occurs largely in the Eocene and Cretaceous with a lesser amount in the Pliocene and Miocene. In the San Joaquin Valley dry gas is of minor importance, being found primarily in the Pleistocene and Pliocene.

All of the dry gas and a very large part of the oil are found in sands, sandstones, or sandy shales. A minor amount of oil occurs in fractured shales and schist. No limestone production has been found.

A high percentage of the oil and dry gas occurs in anticlines or domes. However, nearly every other known type of structure is present. Faulting is found in almost all fields, and in many cases is an important factor in the control of accumulation. In many instances it is the entire means of closure.--From Auth., p.6-7.

3-3143. Knutson, Carroll F., and others. CHARACTERIZATION OF THE SAN MIGUEL SANDSTONE BY A COORDINATED LOGGING AND CORING PROGRAM: Jour. Petroleum Technology, v. 13, no. 5, p. 425-432, 13 figs., 3 tables, May 1961, 8 refs.

A coordinated logging-coring program yielded a significant hydrocarbon-volume map of a portion of the San Miguel-1 reservoir, Sacatosa field, Maverick County, Texas. This map, which isopached the function,

$$h_h = \frac{n}{\sum_{L=1}^n} \phi L (1 - S_{wL}),$$

exhibited its maximum thickness variation in the eastern portion of the field.

A correlation between well potential and perforation points indicated the best initial potentials when perforations were in zones with water saturations within $\pm 10\%$ of $S_w = 5\phi - 75$.

Analyses of the cores and logs from 12 core test wells randomly spaced about a producing well showed that the average producing-zone rock properties are rather uniform within a single well's drainage area.

The dense zones have a limited horizontal continuity. They form barriers to vertical fluid migration which generally are not effective areally over distances greater than 50 ft.--Auth.

3-3144. TO SECURE AN INCREASE OF PROVED OIL AND GAS RESERVES FOR FULFILLING THE DIRECTIVES OF THE XXI SESSION OF THE KPSS: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 3-A, p. 139-141, 1959, pub. 1960.

Goals are set to increase the oil production in U.S.S.R. from 113 million tons in 1958 to 230-240 million tons in 1965 and to 350-400 million tons in 1970. Likewise gas production has to be increased from 30 billion m^3 to 150 billion m^3 in 1965 and to 270-320 billion m^3 in 1970. To achieve this purpose a considerable increase in quantity and in efficiency of revealing and exploration of oil and gas fields is necessary, and scientific investigations have to be strengthened.--C. Voûte.

3-3145. Mustafinov, A.N. THE TASKS OF PREPARATION OF COMMERCIAL OIL AND GAS RESERVES AND OF INCREASING THE EFFECTIVENESS OF GEOLOGIC EXPLORATION IN THE RSFSR: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 3-A, p. 142-145, 1959, pub. 1960.

With respect to the total increase of oil and gas production in the U.S.S.R. in the years 1959-1965 the R. S. F. S. R. has to play the main part. The allotment for geophysical operations and for exploration drilling has been considerably increased. The parts are specified which various regions have to fulfill in the program, with emphasis on the Volga area, the region of the Ural river, and the northern Caucasus. Recommendations are made for obtaining a higher efficiency of the work.--C. Voûte.

3-3146. Markovsky, N.I. THE RELATIONSHIP OF OIL-SOURCE AND COAL-BEARING DEPOSITS OF THE LOWER CARBONIFEROUS OF THE VOLGA-URAL DISTRICT: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 3-A, p. 160-166, map, diag., 2 secs., table, 1959, pub. 1960, 7 refs.

The broad outlines are sketched of the variations in thickness and in lithology of the terrestrial unit of the lower Carboniferous. They are interpreted in terms of different facies: marsh-lake, alluvial-channel, and littoral-marine sediments. A provisional boundary between land and sea is traced, and the presence of valley fills and deltas of large rivers are mentioned. Conditions were favorable for the accumulation of large quantities of organic materials, and coal and oil were formed but under different physical geographic conditions. The major coal deposits have an autochthonous character, with minor beds of autochthonous coal intercalated in between littoral-marine sediments. The oil, however, migrated after its origin from the source rocks into oil-host rocks. Oil and coal both formed on the same flank of the sedimentary basin. A shelf zone with gulfs, lagoons, and estuaries can be distinguished, which was oil-generating. The adjacent alluvial plain acted as a potential zone of reservoirs, where coal deposits also were formed.--C. Voûte.

3-3147. Baba-Zade, B.K. SECURING AN INCREASE OF COMMERCIAL OIL AND GAS RESERVES IN AZERBAIDZHAN SSR: Geologiya Nefti - Petroleum Geology, in translation, v. 3, no. 3-A, p. 146-150, 1959, pub. 1960.

The amount of exploration work to be done under the 7 years plan is outlined, specified according to the various productive and prospecting areas. The necessity is emphasized of an improvement of both equipment and working methods in order to increase the efficiency of the work. This is especially of importance as the average depth of the wells to be drilled is increasing considerably.--C. Voûte.

3-3148. Vereschagin, V. N. FORMATION OF COAL DURING THE CRETACEOUS PERIOD AND ITS ROLE IN THE GLOBAL PROCESSES OF COAL ACCUMULATION. Translated by Eugene A. Alexandrov: *Internat. Geology Rev.*, v. 3, no. 6, p. 482-484, table, June 1961, 9 refs.

P. I. Stepanov suggested that during the Cretaceous there probably took place a considerable accumulation of coal, although that time was always considered to have been a period of attenuation of coal accumulation. The analysis of facies of the Cretaceous deposits in the far east maritime region of the U. S. S. R., as well as those of Alaska led the author to conclude that coal accumulation during the Cretaceous was tremendous. This conjuncture has now been confirmed: the new estimate of coal reserves of the U. S. S. R. has shown the Cretaceous Lena coal field to be the largest in the world. Tremendous reserves of coal are also concentrated in the Bureya, Maritime, Anadyr, and Sakhalin Cretaceous coal-bearing basins of the U. S. S. R., in the Ryōseki basin of Japan, and in the Cretaceous coal deposits of North America, particularly in Alaska where a major coal field very likely exists. Thus it may now be considered that during the Cretaceous there accumulated reserves of coal comparable in immensity to those accumulated during the Tertiary and undoubtedly much larger than those of the Permian, Carboniferous, and Jurassic. It may be asserted that rate of coal accumulation kept ever increasing in the course of geological time, and the Cretaceous may be regarded as a period of very intensive coal accumulation. Following up Stepanov's idea we can point out the knots of Cretaceous coal accumulation: Lena, Alaska, Anadyr, Sakhalin-Maritime. The new data on the Cretaceous coal accumulation should be taken into account in any reconstruction of the history of geological development of the earth and of the evolution of the organic world.--Auth. English summ.

3-3149. Clegg, Kenneth E. SUBSURFACE GEOLOGY AND COAL RESOURCES OF THE PENNSYLVANIAN SYSTEM, SANGAMON, MACON, MENARD, AND PARTS OF CHRISTIAN AND LOGAN COUNTIES, ILLINOIS: Illinois, State Geol. Survey, Circ. 312, 28 p., 5 figs., 4 pls. (3 in pocket), 2 tables, 1961, 21 refs.

Pennsylvanian strata of the NW. shelf area of the deep part of the Illinois basin were studied to determine structure, stratigraphy, and coal resources.

The general structure and stratigraphy of Pennsylvanian strata are reported, with special emphasis on the interval between the top of the Shoal Creek limestone member and the base of the Colchester (No. 2) coal member. The more important "key" members are discussed in both local and regional aspect, and structure maps based on the tops of Herrin (No. 6) coal and Springfield (No. 5) coal are included.

No. 6 coal is the most important commercial coal in the southern part of the area, where No. 5 coal is poorly developed. Conversely, in the northern part of the area, No. 5 coal is of minable thickness and No. 6 coal is thin. Between the areas of maximum development of the 2 coals is an elongate, E.-W. trending tract of about 450 sq. mi. wherein both coals appear to be 3 or more ft. thick.

Limited information concerning the thickness of Chapel (No. 8), Sumnum (No. 4), and Colchester (No. 2) coals indicates that they are generally thin but locally may be of minable thickness. More information is required to determine their potential.

The Springfield (No. 5) coal was mined extensively in the past, but in recent years large-scale mining has been concerned mainly with No. 6 coal. Available information indicates that reserves of No. 6 and No. 5 coals are considerably greater than early estimates suggested.--Auth.

3-3150. Potter, Paul Edwin, and J. A. Simon. ANVIL ROCK SANDSTONE AND CHANNEL CUTOUTS OF HERRIN (No. 6) COAL IN WEST-CENTRAL ILLINOIS: Illinois State Geol. Survey, Circ. 314, 12 p., 4 figs., 2 pls. (in pocket), 1961, 16 refs.

The Anvil Rock sandstone [Pennsylvanian] and related "cutouts," or "washouts," of Herrin (no. 6) coals were mapped in subsurface in W.-central Illinois. Maps were based on data from logs of more than 1,200 drill holes from a 5,400-sq.-mi. area that includes Bond, Christian, Clinton, Macoupin, Madison, and Montgomery counties and portions of Fayette, Marion, Sangamon, and Washington counties.

One map depicts the occurrence and thickness of the Anvil Rock sandstone in W.-central Illinois, showing a typical linear sinuous pattern. A second map shows the thickness of the interval from the base of the Piasa limestone to the top of the Herrin (no. 6) coal. Where no. 6 coal has been eroded, the interval is extended to the base of the Anvil Rock sandstone. This combined isopach-cutout map shows the relationship between maximum Anvil Rock sandstone development and channel cutouts of no. 6 coal as well as areas where the coal is split, thin, or absent adjacent to the major sandstone channel.

The cutouts are related to a stream drainage pattern of late Pennsylvanian age. The presence of the Anvil Rock sandstone in the interval between the Piasa limestone and the Herrin (no. 6) coal and an increased thickness of this interval are guides for predicting coal cutouts in W.-central Illinois.--Auth.

3-3151. Smith, William H., STRIPPABLE COAL RESERVES OF ILLINOIS. PART 3 - MADISON, MACOUPIN, JERSEY, GREENE, SCOTT, MORGAN, AND CASS COUNTIES: Illinois, State Geol. Survey, Circ. 311, 40 p., 5 maps (4 in pocket), sec., 4 tables, 1961, 21 refs.

This third report of a series describing and evaluating strippable coal reserves of Illinois is concerned chiefly with large reserves of No. 2 and No. 6 coals in the western parts of Madison and Macoupin counties and in Jersey, Greene, Scott, Morgan, and Cass counties. Strippable coals are currently defined as beds 18 in. or more thick and having overburden not exceeding 150 ft.

There is now practically no mining in this area of comparatively thin coal, although at one time there was considerable local mining. However, proximity to the Mississippi and Illinois rivers, increasing demands for electrical energy, and improvements in excavating equipment have resulted in renewed interest in the large reserves of coal in these counties.

The information concerning strippable coal reserves is compiled on 2 maps, one for No. 2 and one for No. 6 coal, published on a scale of 1/2 in. to 1 mi. They show outcrops, mined-out areas, and thickness of the coal at 12-in. isopach intervals. Isopach lines divide the overburden into thickness categories of 0 to 50, 50 to 100, and 100 to 150 ft. The reserves are divided into primary and secondary categories. The quantity of strippable coal (estimated according to coal thickness, overburden thickness, and reliability of estimate) are tabulated by township for each county.

A third map, on the same scale, delineates structure contours drawn on the top of No. 2 and No. 6 coals. Stratigraphic relationships in the Pennsylvanian strata of the various counties are shown on 3 N-S. cross sections.

A total of approximately 3 billion tons of strip-

pable coal reserves has been estimated for these 7 counties, divided about equally between the Colchester (No. 2) coal and the Herrin (No. 6) coal. Minor areas of strippable reserves available in the Danville (No. 7), Roodhouse, and Kerton Creek coals are described.--Auth.

14. ENGINEERING GEOLOGY

See also: Geologic Maps 3-2885 through 3-2888; Areal and Regional Geology 3-2897; Geophysics 3-2993.

3-3152. Gilbert, Oliver M., Jr. A DEVICE FOR MEASURING TENSIONS IN WATER: Natl. Research Council, Highway Research Board, Bull. 245 (Natl. Acad. Sci.-Natl. Research Council, Pub. 731), p. 1-9, 6 figs., 2 tables, 1960, 13 refs.

The measurement of negative pore water pressures in soil systems is important in both research and design studies on precompressed saturated clays and partially saturated compacted clays. To date, no equipment that can measure water tensions below absolute zero pressure under conditions of changing external stress has been available. This paper describes such equipment.

In the device described here, the sensing element contacting the soil is a fine-grained ceramic stone, which is connected by a closed water system to a flexible steel membrane. Tension is controlled by externally adjusting the membrane deflection. The absence of a free water surface prevents cavitation.

Calibration data demonstrate that the pore pilot can indeed measure water tensions below absolute zero pressure.--Auth.

3-3153. Yalcin, A.S., and R. McIntosh. SOME RHEOLOGICAL PARAMETERS OF CLAYS AND THEIR THIXOTROPIC BEHAVIOR: Can. Jour. Chem. Eng., v. 39, no. 2, p. 76-80, 10 figs., table, Apr. 1961, 8 refs.

Rheological characteristics and thixotropic behavior of 4 clay minerals belonging to different types of morphology and lattice structure were investigated.

Clay-water samples were prepared at about their liquid limits and the testing was accomplished by unconfined compression applied at different rates of deformation.

From the stress to strain rate relationships the yield was determined as an intercept on the stress axis at zero rate of strain, and the slope gave the viscosity coefficient.

Regain of strength or thixotropic character of the samples was evaluated in terms of the viscosity and yield values at various periods of aging.

The influence of temperature on the aging process was studied using attapulgite at 3 temperatures, 21°C., 36°C., 51°C.

The activation energy of the process of aging for attapulgite was calculated using both viscosity coefficients and ultimate yields. The values were within experimental uncertainty for the 2 sets of data and it was thereby concluded that changes of these parameters were due to a single reaction. The activation energy was found to be 9.4 kcal.mole⁻¹, which suggests a physical rather than a chemical change.--Auth.

3-3154. Titkov, N.I., and other. ELECTRO-CHEMICAL INDURATION OF WEAK ROCKS. Authorized Translation from the Russian: 52 p., 18 figs.,

26 tables, New York, Consultants Bureau, 1961, 5 refs.

The suitability of the electrochemical method for indurating the walls of drill holes has been firmly established. The electrochemical induration of drill-hole walls holds promise not only for the time of drilling but also for the period of exploitation of a well.

The walls of a drill hole may be indurated electrochemically a) by creation of a crust of hardened mixture consisting of clay or loam and binding material (cement, lime, bituminous emulsion, etc.), which is introduced into the space between the wall rock and the electrodes, and b) by increasing the stability of the surface zone of the clay rocks themselves by transforming them through the action of an electrical field.

The strengthening of walls in drill holes by a clay-cement crust is recommended chiefly for the eastern oil regions. The electrochemical transformation of the surface zone of clay rocks is recommended for experimental tests in the southwestern oil regions.--Auth. summ.

3-3155. California, University, Radiation Laboratory, Livermore. THE HUGONOT EQUATION OF STATE OF ROCKS. By David B. Lombard: U.S. Atomic Energy Comm., [Pub.] UCRL-6311, 28 p., 9 figs., 1961, 15 refs.

In considering peaceful applications for nuclear explosions detonated underground, one is concerned with the action of strong shocks which proceed from the center of detonation into the surrounding medium. The propagation of such shocks and their effect on the medium are directly related to the useful purposes to which nuclear explosives can be put. Furthermore, in planning experimental explosions it is highly desirable to predict with good accuracy the effects of the shock. Predictions are based partly on a knowledge of the Hugoniot equation of state.

For these reasons, the equations of state of several common rocks have been measured by Alder's group at Livermore. Plane hydrodynamic shocks were produced by conventional high explosive techniques and transmitted to pellets of the rock by Al plates. Shock times-of-arrival at Al and rock surfaces, and free-surface velocities were recorded by an Ar flash-block technique and a sweep camera. This method has been discussed by various authors. Shock velocity and free-surface velocity are measured in these experiments.

Measurements have been made at pressures ranging from 70 kb. to 900 kb. Rock salt, granite, tuff, marble, dolomite, limestone, basalt, and other rocks have been studied; several points on the P-V curve for each have been measured. Particularly interesting data for granite and basalt have been obtained. Further work is in progress.

The desirability of making in situ peak pressure measurements on shocks generated by actual nuclear explosions has led to the development of an instru-

ment which employs pin-contractors to measure shock velocity and free-surface velocity at locations in the rock medium not far from the explosion. The instrument has performed satisfactorily in high explosive tests. It is hoped that shock stresses from below 100 kb. to over 1 mb. can be measured in this fashion.--Auth. summ.

3-3156. Leet, L. Don. **VIBRATIONS FROM BLASTING ROCK**: 134 p., 70 figs., 12 tables, Cambridge, Massachusetts, Harvard University Press, 1960, refs.

The process of blasting rock involves a series of preparatory steps and a complicated sequence of events during and after detonation of the explosive. The size, depth, and separation of the drill holes, and their separation from a free face influence the results. Rocks respond to explosives in ways governed by their mineral components and history of formation. Of great importance are joints, bedding planes, foliation, and variation in their properties brought about by weathering. Joints are especially important since they are surfaces along which the rock is actually broken before any blasting takes place.

When an explosive buried in rock is detonated, a small volume of rock in the immediate vicinity is shattered by compression. When the pressure front reaches a rock-air boundary, it is reflected back into the rock as a tension front. The combined effect of pressure and tension at the rock-air boundary is to rupture the rock. In the rest of the rock, the pressure front rapidly decays into elastic waves which constitute the vibrations that sometimes shake structures and people.

The effectiveness of an explosive in breaking rock depends on the total energy it releases, the rate at which this energy is released, and the efficiency with which it is transmitted to surrounding rock. These factors are not controlled by any single property of the explosive, but on the other hand total energy is a very useful characteristic by which to rate explosives relative to each other.

Two characteristics of rocks that are important in determining their reaction to vibrations from blasting are elasticity and characteristic impedance. The former is measured by the velocity with which longitudinal waves traverse the rock. Characteristic impedance for rock is defined as density times velocity of longitudinal waves in the rock.

Some of the energy from an explosion in rock escapes from the region of shattering and plastic movement as elastic waves. An important factor is the wavelength. It is differential displacement that causes rupture of materials, and the greatest differential displacement is between points a half wavelength apart. The wavelength L is related to the velocity of the wave's travel, V and its frequency, f by the equation $L=V/f$. A practical rule for estimating wavelength-to-structure-size ratios is to use $L=300$ ft. This means that if a dwelling extends 30 ft. in the path of such waves, no more than 1/10 of any 300-ft. wave would be under it at any instant, and the greatest differential displacement between parts of the dwelling would be 1/5 of the range of the motion.

The best guide to damage-causing possibilities of vibrations is the energy they possess, and the energy can be computed by indirect methods.

The number of tons of stone most efficiently shattered by a pound of explosive together with the area blocked out by boreholes prepared to hold the explo-

sive, determines the total amount of explosive loaded for blast. If for example, a 125-ft. face of limestone is to be blasted for 100 ft. along the face, using holes 20 ft. back from the face, the total volume of rock to be broken would be $125 \times 100 \times 20 = 250,000$ ft.³. At approximately 12 ft.³/ton this represents nearly 21,000 tons of rock. For a powder factor of 4 (4 tons of rock satisfactorily broken by 1 lb. of explosive), the total weight of explosives required for such a blast would be 5,250 lb. This would be distributed among the boreholes to concentrate the greatest energy in the lower parts of the holes. For best breakage and smallest vibration, millisecond delays, starting at one end of the line of holes and progressing along the line, are used.

In tunnel blasting, explosives are detonated in sequence so that the center of the tunnel is taken out first and the rock around it breaks into the relieved region. Long delays separating detonations by a second or more have long been used. The diameter of such a tunnel limits the amount of explosives that can be loaded at any one time. It is impossible to load sufficient explosives fired in sequence to damage structures on the surface without destroying the tunnel itself.

There is a close connection between reduction of vibration by millisecond detonation and the extent to which rock is broken into sizes convenient for removal. Delays improve breakage, and this is probably influenced largely by shock fronts and expanding gases from late-firing holes operating in large numbers of free faces produced by energy from earlier holes that would not have been available if all the holes had fired together.--J. W. Skehan.

3-3157. Rinehart, John S. **ON FRACTURES CAUSED BY EXPLOSIONS AND IMPACTS**: Colorado School Mines, Quart., v. 55, no. 4, 115 p., 93 figs., 8 tables, 1960, 7 refs.

This report has been prepared with a view to setting down in a relatively elementary manner the solutions to a large number of problems connected with fracturing occurring under impulsive loads such as might be generated by explosions and impacts. There is no handbook or reference work which spells out carefully and in comprehensive detail the concepts, information, and formulas which the engineer needs to get on with the solution to his problems. The phenomena associated with failure under impulsive loads are markedly different from those connected with failure under static loads so that the possession of an insight into what will happen in static situations may lead the engineer astray when he attacks an impulsive loading problem. Little attention, however, has been given here to practical applications, the intent being the laying down of sets of basic rules and the completion of a large number of illustrative exercises, using these principles.

Chap. 2, Transient Stress Disturbances, delineates many attributes of the character of transient stress disturbances and the laws which govern their movement through materials, with considerable emphasis being given to reflections at boundaries and transmittal through layered media. These laws are the foundation upon which the remainder of the report rests.

An attempt is made in Chap. 3, Mathematics and Physics of Spalling, to develop an appreciation for the way in which momentums and energies become distributed and partitioned within an impulsively loaded body, concepts presenting some difficulty of assimilation because of their strangeness.

Spalling, a type of fracturing exceedingly prevalent, sometimes troublesome and other times helpful in various engineering operations, is treated in an idealized fashion in Chap. 4, *Some Idealized Spalling Problems*. The intent of this chapter is to give a clear account of spalling and its many ramifications without encumbering the discussion with a large number of effects.

The movement of a transient disturbance is strongly affected by abrupt changes in the physical properties of the medium through which it is traveling. Chap. 5, *Effects of Interfaces and Laminations*, outlines the fundamental character of these effects and in particular demonstrates the limitations which nature, in real materials, places on man's ability to influence these movements.

The peregrinations of transient stress disturbances can be markedly influenced by encounters with free surfaces. A number of representative encounters and situations are depicted in Chap. 6, *The Effects of Body Shape*. The fractures produced by these encounters are not spalls, but the fractures and the conditions which lead to them are closely akin to spalling problems and to a general understanding of fracturing under impulsive loading.

A transient stress pulse is a dynamic thing with its shape constantly changing. The fractures which ensue at any stage in the progress of the wave will be strongly influenced by the shape which the wave has at the instant that fracture occurs. Many factors determine the changes, several of which are discussed in Chap. 7, *Changes in the Shape of a Stress Pulse*.

Chaps. 2 through 7 provide the requisite background material for the discussion of spalling in real materials given in Chap. 8, *Transient Disturbances and Spalling in Real Materials*. There is a paucity of the type of the experimental data needed to formulate realistic descriptions and appraisals. This chapter, through its defects, exemplifies the present state of the practical art of design for spall resistance and directs attention toward a fruitful experimental program.--From introd.

3-3158. California, University, Radiation Laboratory, Livermore. *CAVITY DEFINITION, RADIATION AND TEMPERATURE DISTRIBUTIONS RESULTING FROM THE LOGAN EVENT*. By W. P. Bennett and others: U. S. Atomic Energy Comm., [Pub.] UCRL-3240, Contract W-7405-eng-48, 54 p., 38 figs., 3 tables, 1960, 6 refs.

Following the detonation of the Logan event [Nevada] on Oct. 15, 1958, an exploratory drift was driven to within 160 ft. of ground zero to recover experimental apparatus. Several postshot diagnostic holes were drilled through the zone of effects to obtain temperature and radiation data. The data obtained were used to define the cavity and the thermal distribution in the media surrounding ground zero.

The report contains: 1) a graphical representation of drill hole temperature and radiation; 2) isothermal diagram of area surrounding ground zero from which the thermal energy deposited to the media was obtained; 3) cavity definition diagram from which cavity radii and scaling factors were derived; and 4) blast effects encountered during the postshot excavation of the original access drift.--Auth.

3-3159. Hill, Gladwin. *STILL-WARM CAVERN YIELDS SECRETS OF '57 ATOM BLAST*: New York TIMES, v. 110, no. 37,788, p. 1, col. 2-4, p. 2, col. 3-4, illus., July 10, 1961.

Radiation from the Rainier underground nuclear explosion of Sept. 17, 1957, in Nevada has so diminished in nearly 4 years that it is possible to enter and inspect the explosion cavern itself. Residual heat causes a temperature of 100°F. at the upper end of the chamber. Particles of radioactive fused rock, hardness 7 to 8 and as large as the Hope diamond, were formed. A tour of the cavern and tunnel to it is described.--M. Russell.

3-3160. California, University, Radiation Laboratory, Livermore. *FINAL REPORT ON THE PINOT EXPERIMENT*. By Frank L. Adelman and others: U. S. Atomic Energy Comm., [Pub.] UCRL-6274, 21 p., 5 figs., 2 tables, 1960, 2 refs.

Pinot is the code name for a small chemical explosive experiment carried out in Aug. 1960 in a mine controlled by the U. S. Bureau of Mines at the Anvil Points Experimental Oil Shale Station near Rifle, Colorado. The project was designed to provide some indication of the extent to which gases from a confined underground explosion in oil shale would migrate parallel to the bedding planes.

At 0800 on Aug. 2, 1960, 946 lb. of nitromethane was fired in shot hole no. 1. There was no visible damage to the mine adit or to any structure associated with the workings. Gas samples collected from sampling holes near the shot hole were analyzed for Kr⁸⁵, which had been included with the nitromethane as a tracer. It appears that the Kr⁸⁵ concentration in the samples out to 50 ft. was more or less independent of space and time between +2 and +50 hours. Relatively little Kr⁸⁵ was detected at 125 ft. and none beyond. About (20 + 10)% of the Kr⁸⁵ escaped into the adit.

The results of the Pinot experiment cannot be extrapolated quantitatively to the case of a nuclear explosion in oil shale. Even if the structure at the Pinot site is typical of oil shale, the generation of a smaller quantity of noncondensable gases per unit energy in a nuclear explosion (as compared with a chemical explosion), the shorter time scale of the energy release, and the higher temperatures and pressures encountered will all have a definite influence on the effective containment distance. One can conclude, however, that, if the medium at the site of a potential nuclear experiment is similar to that at Pinot, the radioactive gases will not travel preferentially in direction parallel to the bedding planes, but rather will tend to expand more or less spherically from the shot point. In other words, an explosion in oil shale designed not to vent in a direction perpendicular to the bedding planes will be just as tight parallel to the bedding planes.--Auth.

3-3161. Bell, Alfred H. *UNDERGROUND STORAGE OF NATURAL GAS IN ILLINOIS*: Illinois, State Geol. Survey, Circ. 318, 27 p., 17 figs., 7 tables, 1961, 5 refs.

Natural gas from the midcontinent and Gulf Coast regions is being stored underground in Illinois in 6 areas as of Jan. 1, 1961, and similar storage projects are planned in at least 5 other areas. The storage reservoirs are of 2 main types: 1) "aquifers," or those that originally contained only water, and 2) those that contained oil or gas as well as water.

Gas storage reservoirs now in use have an estimated total capacity of 184 billion cu. ft.

Underground storage facilities perform a vital function in making gas available to consumers in the necessary quantities at times of high demand and at

a cost lower than that of direct pipeline delivery from the distant sources. It is thus possible to serve many more consumers than could be served without the use of underground storage. --Auth.

3-3162. Boegly, W. J., Jr. DISPOSAL FOR RADIOACTIVE WASTES IN NATURAL SALT-FIELD EXPERIMENTS: Purdue, Univ., Eng. Ext. Dept., Eng. Bull. v. 45, no. 2, Ext. Ser. no. 106, p. 577-590, 9 figs., table, March 1961, 15 refs.

Many methods for the treatment or disposal of radioactive wastes have been proposed; among these are conversion of liquids to solids, injection into hydraulically produced fractures in impermeable formations, and direct disposal into salt formations. For the past 3 years research has been underway at the Oak Ridge National Laboratory on the direct disposal of radioactive liquids to cavities in natural salt formations. This paper deals with one part of this program; namely, field experiments in the Carey salt mine at Hutchinson, Kansas.

Salt has been selected as a possible waste-disposal medium because of its impermeability, geographic distribution, thermal conductivity, strength, and abundance.

The large tests in the Carey salt mine are still in operation, and the final results are not yet available. The maximum temperature rise in the waste appears to have been reached, but some salt temperatures are still rising slowly. Some conclusions can be drawn from the plastic flow measurements, but a more exact analysis will be required to determine the actual degree of cavity stability and heat effect on plastic flow. The shape of the final cavity and amount of salt removed from the side walls can only be estimated at this time and will not be determined until the power to the pits has been turned "off" and the cavities allowed to cool before removing the off-gas covers.

Based on current information the temperature rise in the acid cavity will not be as high as predicted by theoretical calculation. This is probably due to heat losses through the metal off-gas covers and the lack of an infinite body of salt on all sides of the cavities. The same thermal results have been obtained in the large tests as in the small-scale and laboratory tests; namely, a lower temperature in the acid waste than the neutralized when operated at equal power levels. Gases released from the large cavities have the same constituents as the gases from the scale models, and have been handled successfully by the off-gas system. The increase in salt temperature resulted in an increased rate of plastic flow; however, the flow rate was slowly decreasing, and a new equilibrium flow rate was being approached. --From auth. introd. & concl.

3-3163. de Witt, Wallace, Jr. GEOLOGY OF THE MICHIGAN BASIN WITH REFERENCE TO SUBSURFACE DISPOSAL OF RADIOACTIVE WASTES: U. S. Geol. Survey, Trace Elements Inv. Rept. 771, 100 p., 20 figs. incl. 9 maps and sec. (in pocket), 1960, 43 refs.

The Michigan basin is a sedimentary basin covering about 122,000 sq. mi. in parts of 5 states and the Province of Ontario. Approximately 1/4 of the surface of the basin is covered by 3 of the Great Lakes, Erie, Huron, and Michigan.

The Michigan basin contains about 108,000 cu. mi. of sedimentary rock, largely of Paleozoic age. The rocks are thickest in the central part of the

Southern Peninsula of Michigan, the center of the basin, where the sedimentary rocks aggregate more than 14,000 ft. These rocks are 47% carbonate, 23% sandstone, 18% shale, and 12% evaporite. About 80% of the rocks were deposited during the early part of the Paleozoic era, Cambrian through Silurian, and the remaining 20% were deposited in the later part of the Paleozoic, Devonian through Permian.

Four general lithologic sequences are recognizable in the basin; each sequence is characterized by lithology that is indicative of several closely related environments of deposition. The Cambrian clastic sequence is composed of sandstone and siltstone that accumulated in nearshore and shelf environments during the Late Cambrian. The carbonate evaporite sequence, which ranges in age from Early Ordovician to Middle Devonian, is composed largely of marine carbonate rocks. At times bioclastic limestone accumulated in the shallow water, whereas at other times chemically precipitated limestone and dolomite were deposited. Periods of restricted hypersaline sea and an arid climate in the Late Silurian and in Middle Devonian are indicated by thick layers of gypsum, anhydrite, and halite interbedded in the carbonate rocks. At times sandstone was deposited in the shallow water along the margins of the basin. The shale-sandstone sequence of Late Devonian and Mississippian age, is composed largely of shale and silty shale, although sandstone, sandy limestone, and evaporites are present locally in the sequence. Apparently the shale-sandstone sequence was deposited in a more confined basin than much of the preceding carbonate-evaporite sequence.

At times sills or shoals restricted circulation in the basin, and sediments rich in humic debris accumulated in the euxinic environment. Deltaic sandstone was deposited on the margins of the basin, particularly during the Mississippian. The coal-bearing sequence, of Pennsylvanian and of possible Permian age, is made up predominantly of continental clastic rocks. Locally marine limestone, gypsum, and anhydrite are present, but these rocks are only a small part of the sequence. The coal-bearing sequence shows the filling of the basin by continental sediments near the close of the Paleozoic.

Widespread stratigraphic units of relatively constant lithology are characteristic of the marine rocks in the Michigan basin. Subsurface control by samples, logs, electric logs, and cores is generally adequate for accurate prediction of the lithologic character of members, formations, and groups of formations throughout much of the basin. In direct contrast, the continental clastic deposits consist of intertonguing lenticular sandstone and shale in which the tracing of individual units is almost impossible without core drilling.

A mantle of glacial drift and alluvial sediments 0 to more than 1,000 ft. thick overlies the Paleozoic rocks throughout much of the Michigan basin. Sand and gravel are being winnowed and reworked in streams and in the Great Lakes, whereas inland in the glaciated areas mud, humic muck, and fresh-water marl are accumulating in the many bogs, swamps, and small lakes that cover large parts of the surface of the basin.

The Michigan basin is roughly elliptical in plan view. The bedrock of this relatively simple structure dips gently toward the center of the basin at 30 to 80 ft. per mi. Relief on the top of the Precambrian basement complex is slightly more than 14,000 ft. Locally the regional dip is modified by small anticlines, commonly with less than 200 ft. of closure. Anticlines trend NW. and lie en echelon throughout much of the basin. The general paral-

ism of trend suggests that the small folds in the sedimentary rocks are the surface manifestations of deep-seated faulting in the basement complex. Normal faults are commonly associated with the antinormal folds. The largest fault in the basin, a normal fault on the W. flank of the Howell anticline in southeastern Michigan, has a vertical displacement of about 1,000 ft. Collapse structures, local zones of complex faulting, and beds of sedimentary breccia are present near the outcrop of formations containing soluble evaporites of Silurian, Devonian, and Mississippian age.

The framework of the Michigan basin formed largely in the late Precambrian. During much of the early Paleozoic the Michigan basin was an embayment on the northeastern side of the larger Central Interior basin. The Michigan basin did not become a separate basin until Late Silurian although some of the earlier Paleozoic rocks show local thickening near its center. Restriction of the sea and accumulation of thick beds of evaporites in the central part of the basin in the Salina formation of Late Silurian age marks the beginning of geosynclinal deposition in the Michigan basin. Subsidence, regional tilting, and local folding took place at other times during the late Paleozoic, but downwarping apparently was never on as great a scale as in the Late Silurian.

Several types of rock may have some possibilities for the subsurface disposal of liquid or solid radioactive waste in the Michigan basin: thick sequences of undeformed shale, thick beds of soluble evaporites intercalated in less soluble rocks, and quartzose sandstone aquifers. Liquid radioactive waste might be disposed of in cavities mined, blasted, or hydraulically fractured in thick sequences of shale or anhydrite. Sintered waste could be placed in cavities mined or blasted in thick sections of shale, salt, gypsum, and anhydrite, or might be placed in cavities developed by solution in thick beds of salt. The placement of liquid radioactive waste in the deeply buried salaquifer facies of blanket-type sandstone aquifers might be considered. However, the problem of assured positive containment and the possibility of migration of waste upward into potable water supplies in the basin tend to discourage the disposal of liquid radioactive waste in sandstone aquifers except where the aquifer is completely isolated from the surface by impermeable rocks and is too deeply buried to be accidentally penetrated by drilling.

Considering the abundance of ground water, the deep circulation of potable water in many of the aquifers in the basin, the dependence of large segments of both rural and urban population on ground water for their water supply, and the relatively imperfect understanding of the behavior of liquid radioactive waste in subsurface rocks, it follows that very careful and detailed study of any favorable areas within the Michigan basin will be needed because of the hazard of incomplete containment of the radioactive waste and the necessity of protecting the public water supply. Continued industrial development of the Michigan basin will demand the exploitation of gas, oil, brine, salt, limestone, coal, and other commercially important mineral resources from the subsurface rocks of the area. Removal of these raw materials will complicate the problem of atomic waste disposal with the necessity of protecting the workers during the recovery of these resources and preventing damage to disposal installations by mining, drilling, or quarrying.--Auth.

illus., Apr. 1961.

The phenomenon of land subsidence in response to removal of ground water is described with special reference to the San Joaquin Valley, California, where about 2,000 sq. mi. have been affected by sinking as great as 20 ft. in 30 years. Rate of subsidence averages 1 ft. for each 13 ft. of decline of water pressure.--M. Russell.

3-3165. Johnson, Joe William, ed. PROCEEDINGS OF SEVENTH CONFERENCE ON COASTAL ENGINEERING, THE HAGUE, NETHERLANDS, AUGUST 1960: 2 v., illus., maps, charts, diags., graphs, tables, Council on Wave Research, The Engineering Foundation, Richmond Field Station, University of California, Richmond, California, 1961, refs.

This conference was sponsored jointly by the Council on Wave Research, Berkeley, California, and the Rijkswaterstaat of the Netherlands. Contents are as follows:

PT. 1. WAVE THEORY AND MEASUREMENTS

Wind Waves and Swell, by R.L. Wiegel.

The Quality of Tabulated Deck Log Swell Observations, by Marvin D. Burkhart and Clifford H. Cline.

Wave Recording on the IJsselmeer, by P.W. Roest. The Use of Radar in Hydrodynamic Surveying, by H.M. Oudshoorn.

An Instrumentation System for Wave Measurements, Recording and Analysis, by H.G. Farmer and D.D. Ketchum.

Splashnik-The Taylor Model Basin Disposable Wave Buoy, by Wilbur Marks.

Wave Height Measuring Equipment, by E.H. Boiten. Etude Theorique de l'Exploitation des Enregistrements de Houle, by P. Caseau.

A Theory for Waves of Finite Height, by Charles L. Bretschneider.

Fifth Order Gravity Wave Theory, by Lars Skjelbreia and James Hendrickson.

PT. 2. BEACH AND SHORELINE PROCESSES

Theoretical Forms of Shorelines, by W. Grijm.

Wave Effect on the Coast Formation and Erosion, by Walenty Jarocki.

Mouvements des Matériaux de Fond Sous l'Action de la Houle, by P. Lhermitte.

The Relationship Between Wave Action and Beach Profile Characteristics, by P.H. Kemp.

Research on Wave Action on Lake Shores and Unlined Slopes of Artificial Earth Structures, by A. A. Pichoughkin.

Experimental Research in Formation by Waves of Stable Profiles of Upstream Faces of Earth Dams and Reservoir Shores, by I.J. Popov.

Essai d'Analyse des Phenomenes Intervenant dans la Formation d'un Estuaire, by M. Banal.

Etude sur Modele du Transport Littoral Conditions de Similitude, by J. Valembois.

Scale Effects in Models with Littoral Sand-Drift, by R. Reinalda.

Littoral Transport in the Great Lakes, by L. Bajornas.

Sediment Movement at Indian Ports, by Madhav Manohar.

Sur l'Evaluation de Certaines Caracteristiques du Transport Littoral a la Base des Donnees Meteorologiques, by Pawel Slomianko.

Stability of Coastal Inlets, by P. Bruun and F. Gerritsen.

The Use of Fluorescent Tracers for the Measure-

3164. SINKING LAND: U.S. Bur. Land Management, Our Public Lands, v. 10, no. 4, p. 12-13, 3

- ment of Littoral Drift, by R.C.H. Russell.
Use of a Radio-active Tracer for the Measurement of Sediment Transport in the Netherlands, by J.N. Svasek and H. Engel.
Rejet de Matériaux à la Mer par Refoulement Hydraulique Risques de Pollution des Plages, by Louis Greslou.

PT. 3. TIDES, TIDAL FLOW, AND STORM SURGES.

- Determination des Denivellements et des Courants de Maree, by F. Gohin.
Estuarine Currents and Tidal Streams, by Rodrick Agnew.
A Study of Diffusion in an Estuary, by W.E. Maloney and C.H. Cline.
Hurricane Tide Prediction for New York Bay, by Basil W. Wilson.
Hurricane Storm Surge Considered as a Resonance Phenomenon, by G. Abraham.
Investigations of the Tides and Storm Surges for the Deltaworks in the Southwestern Part of the Netherlands, by J.J. Dronkers.
On the Use of Frequency Curves of Stormfloods, by P.J. Wemelsfelder.

PT. 4. DYNAMIC ACTION OF WAVES.

- On the Stability of Rubble-Mound Breakwaters, by Jose Joaquim Reis de Carvalho e Daniel Vera-Cruz.
Experimental Studies of Specially Shaped Concrete Blocks for Absorbing Wave Energy, by Shoshichiro Nagai.
Experimental Data on the Overtopping of Seawalls by Waves, by A. Paape.
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La Pression des Vagues contre la Paroi Abrupte, by M.E. Plakida.
The Clamp-on Wave Force Meter, by Lars Skjelbreia.
Model Tests on the Motion of Moored Ships Placed on Long Waves, by F.A. Kilner.
The Dynamics of a Submerged Moored Sphere in Oscillatory Waves, by Donald R.F. Harleman and William C. Shapiro.

- Model Investigations of Wind-Wave Forces, by J.E. Prins.
Model Study of an Isolated Lighthouse Platform at the Sea (Prince Shoal, Quebec), by G.E. Jarlan.

PT. 5. COASTAL ENGINEERING PROBLEMS.

- Sand Transfer, Beach Control, and Inlet Improvements, Fire Island Inlet to Jones Beach, New York, by Thorndike Saville.
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La Defense et le Maintien des Plages Belges Entre Zeebrugge et la Frontiere Neerlandaise, by J.E.L. Verschave.
The Dikes of the Polders in the IJsselmer, by M. Klasema and C.H. de Jong.
Coastal Protection Works and Related Problems in Japan, by Masashi Homma and Kiyoshi Horikawa.
A Brief Outline of the Ise-Wan Typhoon, by Hiroji Otano.
Investigation of Destroyed Structures and the Reconstruction Program: Ise-Wan Typhoon, by Senri Tsuruta.
Waves on the Pacific Coast and on the Coast of Ise Bay Caused by the Ise-Wan Typhoon, by Takeshi Ijima, Shoji Sato, and Hisashi Aono.
The Damages of Coastal Dikes and River Levees and Their Restoration, by Masanobu Hosoi, Yasuteru Tominaga, and Hiroshi Mitsui.
On the Effect of Configurations of the Coast on the Storm Surges in the Ise Bay, by Kiyoshi Tanaka and Akira Murota.
A System of Radio-Location Used in the Delta Area, by R.H.J. Morra.

15. MISCELLANEOUS

- 3-3166. Krauskopf, Konrad B., and Arthur Beiser. **THE PHYSICAL UNIVERSE:** 536 p., illus., approx. 175 figs., tables, New York, McGraw-Hill, 1960, refs.

An introductory textbook in physical science encompassing physics, chemistry, astronomy, and geology. The book emphasizes the basic concepts and the historical and philosophical development of our understanding of the natural world. The emphasis is on the intellectual approach of science, particularly its demand for experimental evidence and the role played by the imaginative, unconventional thinker.

Includes chapters on: The Sun and its Family; Force and Motion; Gravitation: Energy; Solids, Liquids, and Gases; Basic Chemistry; The Periodic Table; Electricity; Currents and Magnetic Fields; Light; The Atomic Nucleus; Atomic Structure; Subatomic Chemistry; Fundamentals of Chemistry; Organic Chemistry; Rocks and Minerals; The Changing Crust; The Atmosphere; Within the Earth; The History of the Earth; The Sun; The Stars; Structure of

the Universe; Evolution of the Universe. --L. M. Dane

- 3-3167. Emmons, William H., and others. **GEOLOGY: PRINCIPLES AND PROCESSES:** 5th ed. 491 p., illus., maps, secs., diag., tables, New York, McGraw-Hill, 1960, refs.

The fifth edition provides a basic introduction to physical geology for the student planning to major in earth sciences. At the same time it challenges the interest of the student seeking a cultural course in a natural science.

Included are short treatments of fringe topics in meteorology, climatology, soils, oceanography, and seismology, which for exigencies of time or other considerations some teachers may prefer to omit. Furthermore, each chapter has been made a fairly complete and independent unit to allow greater versatility of presentation. The text is organized to make possible any sequence of chapter assignment. The order of presentation in this edition differs

in several ways from that of previous editions. Minerals, volcanism, igneous rocks, and sedimentary rocks are treated early to prepare students for concurrent laboratory work on earth materials. Discussion of wind and ground water follows, rather than precedes, the more important topics of stream erosion, glaciation, and shore processes. The section on the effect of geologic structures upon stream erosion has been restored to the chapter on stream work. Special attention is given to rainwash, streams, and wind in dry-land areas. The geologic timetable and the measurement of geologic time by radioactivity have been removed from the Appendix and placed in Chap. 3.

One significant difference from previous editions is the treatment of the economic aspects of geology at appropriate places within the text instead of in a separate chapter at the end. Discussion in context of such practical considerations as the weathering of sulfide ores, the accumulation of Fe-rich or Al-rich laterite, and the formation of placer deposits generally sharpens interest in the geologic process involved and gives point to an otherwise academic discourse.

The contents of this edition have been extensively revised and brought up to date. The edition also includes some results from the International Geophysical Year investigations. The glossary is a new feature and is located at the end of the book to give it greater reference value. Added to the Appendix are a reference list of chemical symbols and a set of keys to the identification of rocks.--From pref.

3-3168. Sullivan, Walter. CANADA EXPANDS ARCTIC EXPLORING: New York Times, v. 110, no. 17,787, p. 44, col. 3-7, map, July 9, 1961.

Canada is engaged in extensive exploration of its far N. in order better to plan its transport system, map its natural resources, test theories on continental glaciation, and provide geophysical data for mapping and missile-flight calculations. The Polar Continental Shelf Project of the Canadian government is the largest of 3 expeditions in the field. A Canadian-American expedition sponsored by the Arctic Institute of North America is based on Devon Island and is making studies of the influence of glaciers on ocean fertility. An expedition sponsored jointly by McGill University and Dr. George Jacobsen is based on Axel Heiberg Island and is studying the history of that island from the evidence afforded by plants, rocks, ice, and erosion by ice and water. It has found peat beds shown by radioactive carbon dating to be 4,000 years old.--M. Russell.

3-3169. Peyton, Garland. GEOLOGICAL INVESTIGATIONS IN GEORGIA, 1960, DEPARTMENT OF MINES, MINING AND GEOLOGY: Georgia Mineral Newsletter, v. 13, no. 4, p.141-146, map, Winter 1960.

The Georgia Division of Mines, Mining and Geology works independently and in conjunction with the U.S. Geological Survey. Projects sponsored independently include geologic mapping of Fulton and Forsyth counties and the Brevard belt; Sr-Ba, Sr-Ca content of marbles of the Brevard belt; determining and correlating Piedmont isotherms; age measure-

ments of Piedmont rocks; and the distribution of P in Georgia granitic rocks. Aside from these activities there are joint projects in water resources with U.S. Geological Survey, Water Resources Division.--J.G. Lester.

3-3170. Vyshivkin, D.D. COMPILATION OF SOIL SALINITY MAPS FROM GEOBOTANICAL DATA. Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3, no. 6, p. 501-506, June 1961, 9 refs.

This paper covers not only the use of vegetation for compiling soil salinity maps, but indicates that soil salinity and vegetation anomalies may lead to discoveries of oil- and gas-bearing structures. In map compilation, the author stresses the need for correlating studies of various plant associations with borehole samples. The usual method was to take samples from the bottom of the borehole, from the root horizon, and from overlying horizons. The importance of defining the type of soil salinity (sulfate, chloride or sulfate-chloride) is emphasized. Examples are given where aerial observations of the vegetation led to further fruitful investigations. In closed basins, sulfate salts tend to be concentrated on the perimeter, chlorides at the bottom. Conditions contrary to this warrant investigation. In the Maly Uzen region, for instance, growth of halophytes on an anticlinal structure, where drainage would be expected to create a low level of chloride salinity, led to the discovery of subsurface salt structures. On the Mangyshlak peninsula, an extensive system of faults was located by a chain of mounds of halophytic vegetation which followed one of the faults of the area.--A. Eustus.

3-3171. Kasyanova, M.S. AEROVISUAL GEOBOTANICAL OBSERVATIONS IN DESERTS AND SEMI-ARID REGIONS. Translated by Gaida M. Hughes: Internat. Geology Rev., v. 3, no. 7, p. 626-628, July 1961.

The techniques of aerogeologic observations and the coordination of such observations with ground studies are described. Some broad distinctions of plant associations are described, notably those including various species of sagebrush (*Artemisia*), beachgrass (*Calamagrostis*), *Tamarix* and various desert grasses. Certain species are best mapped when seasonal color changes occur. The violet bloom of the halophyte *Statice suffruticosa*, for instance, makes it possible to distinguish saline areas on the Ustyurt plateau. Aerial observation gives the supervisor a chance to check the mapping accuracy of subordinates.--A. Eustus.

3-3172. Vance, Maurice M. CHARLES RICHARD VAN HISE, SCIENTIST PROGRESSIVE: 246p., 10 pls., Madison, State Historical Society of Wisconsin, 1960, refs.

Charles Richard Van Hise, 1857-1918, was an authority on the geology of the Great Lakes region and the Precambrian; he was a pioneer in metamorphic and structural geology. From 1903 to 1918 he was president of the University of Wisconsin.--M. Russell.



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